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FOUNDRY TRADE JOURNAL

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Restrictive Trade Practices Act, 1956

The Federation of British Industries deserves much credit for publishing a concise guide for industrialists on the Restrictive Trade Practices Act, 1956*, for it is indeed complicated. It appears specially to be directed against trade associations, which fix prices, quotations, sales conditions and so forth. The one exception cited is the Iron and Steel Corporation where the conditions have been approved by the Iron and Steel Board and the Board of Trade. The position now is that all trade agreements have to be registered with the Registrar (Mr. R. L. Sich, C.B.) at Chancery House, Chancery Lane, London, W.C.2. Part of this official's task is to bring all agreements before the Restrictive Practices Court for assessment as to whether they are or are not contrary to public interest. The agreements are filed in two sections—public and secret, the former being open to inspection on the payment of a fee.

Border-line cases, such as the trade/technical associations, would be well advised to get the Registrar's opinion as to the need to register. The Restrictive Practices Court has the status of a High Court, so that only members of the Bar have the right of audience. Even overseas agreements will be dealt with, by restraining the UK parties from giving effect to them.

The most important section of the guide is Section V which details seven circumstances which can be taken into consideration when determining whether an agreement is against the public interest. First, there is the question of protecting the public against injury in connection with the consumption installation use of those goods. The second relates to the removal of the restriction denying the public —as users—the existing substantial benefits. This is an important clause as affecting quality, wide choice of product, good service and widespread distribution. The third covers the case where one outsider—a non-member—could prevent, or restrict, competition. The fourth refers to where agreement is necessary for dealing with a firm holding a preponderating position—over half—as a supplier. The fifth envisages circumstances where the removal of a restriction would have an adverse effect on employment either in an area or in the industry. This especially applies where employment in one area—say Falkirk—is largely dependent on one industry. The sixth one considers the effect of the removal of a restriction as possibly detrimental to the export trade, while the last takes cognizance of previous decisions before the Court, which has found in favour of an agreement.

* Restrictive Trade Practices Act, 1956, published by the Federation of British Industries, 21, Tothill Street, London, S.W.1; price 4s.

S.G. Iron Licensees

Sixth International Conference

The sixth international conference of S.G. Iron Licensees, convened by the Mond Nickel Company, Limited, in conjunction with Metallgesellschaft A.G., was held from August 29 to 31, in Essen. It was attended by over 270 representatives of licensees in 19 countries. At the technical sessions in the Haus der Technik, Essen, the chair was taken by Dr. L. B. Pfeil, director of the Mond Nickel Company, Limited, supported by Dr. W. Overath of Metallgesellschaft A.G., and Dr. H. Timmerbeil of Knorr-Bremse G.m.b.H., the president of the German S.G. Iron Producers' Association. The wide range of the 23 papers offered for discussion demonstrated continuing progress in manufacturing methods and the increasing importance of s.-g. iron in industry.

New Alloy Available

Particular interest was shown in a new nickel-free calcium/silicon/magnesium/iron pre-alloy for the production of spheroidal-graphite in cast iron. This material which is known as No. 55 alloy, has been developed as the result of co-operative investigations by Metallgesellschaft and Süddeutsche Kalkstickstoff-Werke. It has already been subjected to comprehensive tests in large-scale foundry conditions with full technical and economic success and is now commercially available to all licensees.

Users of s.-g. iron reported experience in various branches of the engineering industries, where the adoption of s.-g. iron castings has resulted in longer service life, improved functioning of components, more favourable strength/weight ratio, and other advantages. The reports made at the meeting received interesting confirmation from the exhibits shown at the GIFA (Internationale Giesserei-Fachmesse), where, at a number of stands, leading firms were showing s.-g. iron castings for use in a variety of engineering industries.

Works Visits

An important feature of the conference was a series of works visits. On the first day the delegates were received by Schmiedag A.G., Werdohl, where there was a demonstration of production of hollow crankshafts for the automotive industry and by Gebrüder Eickhoff, Bochum, where a sealed ladle of the S.K.-B. type was seen in operation. Both foundries are using mains-frequency furnaces of the coreless type as their melting units for s.-g. iron. On the morning of the second day a tour was made of the laboratories and the foundry of F. Krupp A.G.: during this visit the Krupp basic hot-blast cupola was shown in operation and the use of No. 55 alloy was demonstrated.

As in earlier years, the conference programme included a number of social events. At the close of the first day's tour the German S.G. Iron Producers' Association were hosts to the delegates and their ladies under delightful conditions at the Schloss Hotel, Hügenpost, and on the evening of the second day the Mond Nickel Company were hosts to the delegates at dinner at Hotel Kaiserhof, Essen. The conference closed with a cocktail party at the same venue.

A programme arranged for the 40 ladies who accompanied delegates to the conference included visits to the Beethoven House and other places of interest in Bonn, to Schloss Brühl, and to Schloss Burg, in the Bergisches Land, where, in the Hall of the Knights, a concert of chamber music was arranged.

Magnesium in Rockets and Earth Satellites

In 1957, Britain is to fire rockets about 100 miles into space as part of the International Geo-Physical Year. America is to launch earth satellites to between 300 and 500 miles up. Both projects utilize magnesium alloys—the British one incorporates a cylindrical casting, about 20 in. long, 17 in. o.d. and $\frac{3}{16}$ in. thick, to hold the scientific apparatus, while the American satellite will take the form of a 20 in. dia. sheet-metal sphere. The latter is designed to encircle the earth every 90 min. at 18,000 m.p.h., and will be made by Brooks & Perkins Inc.

The British single-stage research rocket is being designed by the Royal Aeronautical Establishment. Magnesium Elektron, Limited, is manufacturing the centre body casting in their creep-resistant, pressure-tight and weldable alloy ZREI. This contains 2.2 per cent. Zn, 0.6 per cent. Zr, 2.7 per cent. rare-earth metals and the balance magnesium. The casting will be originally 1 in. thick, then machined to $\frac{1}{8}$ in. wall thickness. The problem is to achieve ultra-light weight while meeting an elevated temperature requirement (up to 200 deg. C.) and the choice of this alloy enables the use of a single piece casting in magnesium rather than a fabricated structure in heavier metal.

New Title for Engineering Exhibition

The Engineering, Marine and Welding Exhibition has, over a period of 50 years, been recognized as the shop window of British engineering and allied trades. Known first as the Engineering and Machinery Exhibition, and thereafter for many years as the Shipping, Engineering and Machinery Exhibition, the title and subtitles have, from time to time, been modified to take account of natural developments in the engineering industry. Arising from British progress in nuclear power, it is fitting that this internationally famous show should display British achievements in the relatively new engineering techniques required in the development of nuclear energy. In 1957, the Engineering, Marine, Welding and Nuclear Energy Exhibition will, as its new title suggests, focus world attention on British achievements in this field. The organizers are F. W. Bridges & Sons, Limited, and the dates August 29 to September 12.

British Standard Revised

Metal Lavatory Basins for Domestic Purposes (B.S. 1329 : 1956)

British Standard No. 1329 which has been revised, specifies requirements for lavatory basins intended mainly for domestic use and made of enamelled cast iron, enamelled pressed steel or stainless steel. The basins are designed for use with taps, wastes and brackets complying with British Standards B.S. 1010, 1184 and 1255 respectively, although other fittings can be used. The overall dimensions of the basins are the same as for those in ceramic material. Tests are now given for resistance of the enamel coating to acids, alkalies and abrasion; and requirements are specified for an additional grade of stainless steel. Details of suitable pedestals are given where this method of support is required. Copies of this British Standard may be obtained from the British Standards Institution, Sales Branch, 2, Park Street, W.1. Price 3s.

Düsseldorf Diary

By A. R. Parkes

For the 200 or more British delegates attending the International Foundry Congress at Düsseldorf, Germany, the period from September 1 to 9 occupied by the main events will long be remembered as one crammed by a programme of immense technical interest, time-consuming but rewarding assimilation of "foundry" data, and a few well-earned breaks for the lighter forms of social intercourse. To show that though strenuous in its demands, the Congress has indeed been valuable is the purpose of the account which follows. This first section of the report is a day-to-day account of the events of the Congress; it is intended in future sections to deal with the three major subdivisions—the papers, the works visits and—possibly of major importance—the exhibitions of foundry practices, plant and equipment. Through the medium of these columns even non-participants may thus glean information of new processes and plant which can usefully be applied in domestic foundries and, by proxy as it were, savour perhaps some of the experiences of those fortunate enough to be of the party.

Preliminary

Friday, August 31

For the main body of delegates and their wives, August 31 was spent in travelling to Düsseldorf. Helped by efficient organization, the UK contingent had a fairly uneventful and comfortable trip, the sole exceptions being one gentleman whose luggage was mislaid (fortunately only temporarily) and a second gentleman and his lady, part of whose luggage—as a result of a mishap to a porter's trolley on the quayside—is presumably now lying on the sea-bed.

Saturday, September 1

The majority of the delegates had the afternoon and evening free for inspection of the exhibitions, etc., but for the official delegation from each country and their ladies, there was a reception by the Lord Mayor of Düsseldorf, Mr. J. Gockeln, at Benrath Castle—a noble and imposing building of considerable antiquity on the outskirts of the city. Light refreshments were served. The major events were printed in the JOURNAL of September 13 (Fig. 1 shows Mr. V. C. Faulkner receiving the award of honorary membership at this session).

Sunday, September 2

For this day was planned a "get-together" event for the whole body of congressists, consisting of a sightseeing boat trip on the Rhine. The reaches of this river at Düsseldorf being of somewhat low scenic interest, the party entrained first for Rudesheim, some 150 miles or more up river, the return journey being by motor-boat on the river. Despite attendance in such overwhelming numbers as to almost swamp the catering arrangements on the boat, the trip was quite a success and the scenic beauties of the towering banks and impossible-looking castles perched up on them were well appreciated. The somewhat tedious finish of the trip was avoided by some who landed for sightseeing at Cologne and later return to Düsseldorf by rail.

Technicalities

Monday, September 3

The serious business of the Congress was resumed on Monday morning at sessions in the Robert Schumann Hall devoted to a symposium on "Design and Casting". This comprised five short lectures in the morning and a like number in the afternoon, featuring *inter alia* the advantages of cast components; recent developments in the four major metallic subdivisions of the industry—iron, steel, malleable and non-ferrous. Developments of moulding and casting methods; shell moulding; small castings designing to suit production method and co-operation on design made up the balance of the topics. Many of the UK delegation would have liked to attend these lectures but unfortunately the simultaneous-translation equipment was not functioning at this period so that only those competent to follow the mother tongue of the lecturers were able to profit fully.

As an alternative, *congressistes* were offered a choice of eight works visits and most of the UK contingent took advantage of this arrangement. In this series, the following foundries accepted and entertained organized parties: Deutsche Edelstahlwerke AG; Gustav Lauterjung GmbH; Ostermann & Company; Eisenwerk Hilden AG; Gussstahlwerk Oberkassel AG; August Engels GmbH; Wilh. Engstfeld KG; Klockner-Humboldt-Deutz AG and J. G. Schwietzke, Metallwerke.

This last-named foundry is the family business of the president of the German Foundrymen's Association, Dr. Ing. habil. G. Schwietzke and was the one selected by the writer. Two busloads of visitors to the works, which is on the outskirts of Düsseldorf, were first received and addressed by the president and handed an attractive cast model in bronze, in addition to a brochure of the works, as a souvenir. The foundry*, which is one of the most important bronze foundries in the area, has a total output of about 200 to 250 tons per month, mainly of the 85/5/5/5 type of alloy, but of course many others besides.

The official International delegates of the various associations spent the afternoon on work for the International Committee of Foundry Technical Associations, mainly on the preparation of a defects

* Shortly to be described in the JOURNAL.

Düsseldorf Diary

atlas and an international foundry dictionary. Then in the evening these delegates were received by the VDG president in the Rhinegold room of the Rhineterrace restaurant, close to the Congress halls, and later, dined together. The delegates were also meeting on the Tuesday (testing committee) and Friday (main committee) and on the Wednesday they attended a reception by the president of the Düsseldorf Chamber of Commerce at Jagerhof Castle.

Ladies' Programme

So great was the attendance at the Congress, that all through the programme, duplicate and triplicate works visits were arranged and this applied also to the functions arranged specially for the ladies. These latter included sightseeing day and half-day trips in and around Düsseldorf, visiting historic castles and museums, fashion shows, inspection of a glass works, a soap works and a silk works. These proved most successful despite some congestion caused by the unexpectedly high attendance of ladies. In the main events of course—the opening and closing ceremonies, banquet and the like—the ladies participated with their menfolk. In addition, a number of parties toured the headquarters of the VDG and their "Foundry House"—technical and research centre—in Düsseldorf. Monday evening was free for most of those attending the Congress.

Tuesday, September 4

Another series of works visits was the main item on the programme for Tuesday; several occupied the full day and one, to the Volkswagen car works at Wolfsburg, close to the East German frontier, took from 6 a.m. until about 1 a.m. the following morning. Several from the UK delegation participated in this marathon event, but the writer visited the Krupp iron foundry at Essen. This proved most interesting and was admirably arranged, the party being entertained to luncheon by the firm at a restaurant close to the Villa Hugel, previously one of the residences of the Krupp family and now a national museum. After lunch, this museum, which contains valuable relics, books and models tracing the German cultural development since pre-Roman times, was visited. Adjacent to the museum is an exhibition featuring present-day design in all manner of diverse industries, somewhat similar to the permanent Design Centre in London.

FIG. 1.—*Dr. Schwietzke congratulating Mr. V. C. Faulkner when being awarded honorary membership of the German Foundrymen's Technical Association.*

The works visited by other parties included Duisburger Kupferhutte; Eisenwerk Wanheim GmbH; Eisenwerke Mulheim-Meiderich AG; Eisenwerke Gelsenkirchen AG; Bergische Stahlindustrie KG; Gussstahlwerke Bochumer Verein AG; Ruhrstahl AG; Henrichshutte; Gussstahlwerke Wittman AG and Walter Hundhausen KG.

That evening there was a special variety entertainment for members and ladies in the Rheinhalle, a beautiful circular hall with a very lofty roof, close to the Congress centre. Here a number of internationally known "stars" provided light relief for tired congress members.

Wednesday, September 5

The whole of Wednesday was given over to technical sessions, though of course the exhibitions, as on every other day from September 1 to 9 inclusive, were also open and, in fact, very well attended. Although the simultaneous translation of the technical papers—through earphones—into English and French was very helpful, in the case of English at any rate, the service was slightly marred by having an English-speaking German for the work whereas the reverse might have been better. In general, the papers presented followed the list previously published in the JOURNAL*; but with the exception of the third American contribution "A Moisture-free Moulding Sand for Precision Castings" by K. A. Miericke which was replaced by one on "Feeder-head Neck Sizes" by R. Namur (Belgium).

Some of the technical sessions were well attended and this comment applied *inter alia* to such items as the British exchange paper on "Shell-moulding Theory," by Dr. B. H. C. Waters and A. Braybrook, and the film and paper on "The Automatic Buhrer Moulding and Casting Plant," emanating from the George Fischer works at Schaffhausen. Some other sessions, however, showed the effect of having very attractive foundry exhibitions next door. However, this arrangement of dual events seemed to work well, for the exhibition was the major attraction for those for whom a particular subject was without interest or who had language difficulties. Also, throughout the week there were almost continuous sequences of film shows in Hall A2, many of these with commentaries in English.

* See JOURNAL, July 12 issue, p. 57.

Discussion Handicap

Some criticism was expressed of the arrangements for presenting the papers, it seemed that for each of these the authors were allocated 75 per cent. of the time for presenting their contribution—usually in full, the chairman of the session added comments and "thank you's" taking about a further 15 per cent. and the mere 10 per cent. remaining was hardly adequate for discussion. The method practised by the Institute of British Foundrymen, and many other technical societies, of circulating the text of the papers well before the conference and allowing the author only about 10 minutes of the session to introduce the salient points and conclusions, certainly has much to commend it and is usually the prelude to valuable discussion. However, no doubt many attending the Düsseldorf Congress will desire to study the papers further at their leisure*, and if they have queries these can be resolved by correspondence with the authors.

Relaxation on Wednesday evening was provided by a visit to the hundred-year-old beer cellar of the Dieterich Brewery in Düsseldorf. Here it is estimated that numbers approaching 1,000 spent a convivial evening in one of the vaulted cellars, to the accompaniment of a full-strength brass band and liquid refreshment appropriate to the occasion. Such was the attendance, however, that even this huge hall could not take all who came along, and many cut short their stay to make room for others.

(To be continued)

* Abstracts and some of the papers in entirety will be published in the JOURNAL, and the others (in German) are available singly on loan to UK readers, on application to the Editor.

Publications Received

List of Publications. Issued by the Aluminium Development Association, 33, Grosvenor Street, London, W.1.

This 28-page booklet is of the type one keeps, as it is a valuable source of information on easily obtainable technical literature covering all phases of the use and application of aluminium. Much of the work cited is free of charge. The booklet is well arranged for easy reference.

GEC Simon-Carves Atomic Energy Group (No. FC3385). Issued by the General Electric Company, Limited, Magnet House, Kingsway, London, W.C.2.

This nicely illustrated 16-page brochure gives a popular well-worded account of potentialities of the new nuclear power stations and what they mean to the future well-being of the country. One interesting fact disclosed is that 80 per cent. of these installations follow conventional lines.

Definitions of Heat Insulating Terms and Methods of Determining Thermal Conductivity. Published by the British Standards Institution, 2, Park Street, London, W.1. Price 5s.

Fundamentally the question of insulation is a part of fuel economy. As the campaign has spread right down to the manufacture of domestic-heating appliances, many more people must familiarize themselves with the subject, and the issue of this 24-page pamphlet is to be welcomed, for it discloses and defines all the terms and constants used.

Steel Castings for Rolling Stock. Issued by the British Steel Castings Research Association, Broomgrove Lodge, Broomgrove Road, Sheffield, 10.

This well-produced interesting booklet tells something of the history of the railways, and stresses the recent change-over to electric traction. One section deals with some of the problems of railway operation, and clearly exposes the impact of these on the designer and manufacturer. The extraordinary feature of this booklet is that it is not until the last half-a-dozen paragraphs that reference is made to steel castings. On the other hand, the booklet is illustrated with a series of pictures of castings, some of which are really quite impressive—especially those of a single-piece locomotive frame cradle and a bogie for a 1,200 h.p. diesel-electric locomotive. It is an instructive and interesting brochure.

Accidents—How They Happen and How to Prevent Them. Published for the Factory Department by Her Majesty's Stationery Office, York House, Kingsway, London, W.C.2; price 1s. net.

Over three pages of this booklet are devoted to foundry accidents. The first item deals with a prolific source of eye injuries and relates to the pouring of moulds without using goggles. The second deals with a man stumbling and dropping a moulding-box part on his foot. It tells a double story as the cause of the stumble was an iron bar which had been dropped in his path and just left there, whilst the severity of the consequences was due to the man not wearing safety boots. Of the two other cases reported, one was due to protruding bolts on a tumbling barrel and the second an improved design for a special type of moulding-box weight. Two patternshop accidents are also included; in one of these a pair of scissors would have been infinitely preferable to the use of a potentially dangerous circular saw for cutting some thickness pieces from cardboard.

Hand and Machine.—Being the annual report of the Rural Industries Bureau, 1956. Published by the Bureau from 35, Camp Road, Wimbledon Common, London, S.W.19. Price 1s. 6d.

There is a phrase in the foreword which reads: "It is unfortunate that legislation drafted for large-scale industry must be rigidly applied to the small industries." This view has on several occasions been expressed in the JOURNAL. Moreover, the belief is held that some of the small, country jobbing foundries could well be classed as rural industries and whilst perhaps they could not be helped technically by the Bureau, they could probably benefit by the simple costing system it inculcates. These rural industries are important. They find work for 36,500 workers and the gross annual turnover is of the order of £40 millions. With the advent of the mechanized firms, there is much work for the country engineer as a blacksmith and welder. The Bureau is Government financed, has been operating since 1921 and has a good record of success.

Mobile Load Conveyor. A four-page leaflet received from J. Collis & Sons, Limited, Regent Square, Gray's Inn Road, London, W.C.1, illustrates and describes the LoadaVeyor—a mobile belt conveyor, which is adjustable as to the inclined angle used, and also as to height when working in the horizontal plane. Additionally the machine is reversible. Ten different types of belt material are available. This leaflet is obtainable on writing to Gray's Inn Road.

Birlec Apprentice Training Centre

Birlec, Limited, furnace manufacturers of Birmingham, have been training apprentices in their works for some considerable time, but in view of the company's plan for expansion and the need to ensure a continuing supply of trained men of the highest calibre, an ambitious new apprentice scheme has been launched. Over 40 new apprentices have been recruited this year, bringing up the total strength to almost 60, and a new Apprentice Training Centre has been built. Four full-time instructors have been appointed, two of whom have previously held lecturing appointments in well-known technical colleges—at the Birmingham College of Technology and the National Foundry College, Wolverhampton. It is anticipated that the new scheme will cost approximately £20,000 a year to run.

Situated at Wood Lane, Erdington, Birmingham, about a quarter of a mile from Birlec's head office and works, the Training Centre, accommodated in single storey buildings, occupies about 10,000 sq. ft. of floor space. Providing workshop, drawing office and lecture room facilities together with staff offices, locker rooms and cloak rooms, the buildings are spacious, light and airy. Whilst full advantage has been taken of natural lighting, artificial lighting of the most recent design has been incorporated.

Measuring approximately 60 by 20 ft. the drawing office is furnished with 24 double elephant drawing stands, fitted with parallel-motion drafting units. Each has its own reference table so that apprentices will be working with equipment similar to that used in the production drawing offices of the company. Apprentices will be supplied with individual sets of drawing instruments, set squares, scale rules, etc. The workshop of similar dimensions has likewise been provided throughout with new equipment. Two 6½ in. lathes and three 3 in. lathes have been installed together with three 2 h.p. shapers, two ½ h.p. drillers, a 3 h.p. milling machine, a ½ h.p. grinder, a 1 h.p. saw and a hand bending machine. Not only is the workshop equipped with benches for fitting, plating and welding, but it also has its own self-contained stores.

When planning the lecture room, consideration was given to the need for dual-purpose benches that would not only be suitable for taking down instructions but also adequate for use in experimental work. Besides those provided in the lecture room, sliding blackboards have also been provided in the drawing office and workshop, both of which have glass partitioned offices for the instructors in charge.

Instruction Courses

Two main courses are provided, "technical" and "craft," each of not less than five years' duration. All trainees spend their first year on preliminary courses in the Centre to find the direction in which their abilities lie, and to give them an insight into the fundamentals of engineering with particular reference to those branches with which Birlec is concerned. After this probationary period, apprentice indentures must be signed dated from the trainee's 16th birthday or date of engagement, whichever is the later. Training is then continued in appropriate departments for the remainder of the five-year period, selected apprentices returning to the Training Centre for advanced instruction at an intermediate stage. All trainees are also required to attend suitable courses at local technical colleges for at least one day per week. Selected apprentices may be offered the opportunity of attending sandwich courses of four to five years at a college of technology, leading to qualification for membership of the appropriate professional engineering institution.

Steel Output in August

Up to the end of August the steel industry this year produced 13,610,000 tons of crude steel, as against 13,030,000 tons in the same period of last year.

The Iron and Steel Board announced on September 13 that steel production in August, which was affected to a greater extent than the corresponding month of 1955 by the extent of holidays and like that of May, June, and July was also affected by a ban on overtime by maintenance workers, was at the rate of 340,600 tons a week. In August, 1955, production was at the rate of 345,100 tons a week.

The following table gives the latest steel and pig-iron output figures (in tons) and compares them with earlier returns:—

Period.	Pig-iron.		Steel ingots and castings.	
	Weekly average.	Annual rate.	Weekly average.	Annual rate.
1956—May.. ..	246,500	12,820,000	396,400	20,612,000
June ..	239,600	12,459,000	379,700	19,744,000
July.. ..	240,400	12,498,000	326,400	16,971,000
August ..	235,900	12,265,000	340,600	17,712,000
1955—May.. ..	241,800	12,574,000	401,600	20,884,000
June ..	216,800	11,274,000	364,200	18,939,000
July.. ..	230,800	12,000,000	307,700	16,002,000
August ..	236,200	12,282,000	345,100	17,946,000

Non-ferrous Club

Addressing the Non-Ferrous Club at the Queen's Hotel, Birmingham, on September 5, Mr. L. H. Tarring, who had recently returned from a visit to the Rhodesian Copper Belt, spoke of the important developments taking place in the copper mines. He emphasized the difficulties with which the companies were faced in carrying out expansion projects, and spoke of the tremendous distances over rough country through which materials had to be transported. For European workers the standard of living was very high, and there was a boom-town atmosphere which was causing some concern to senior company officials. In reply to a question, he said he thought there was little immediate prospect of the policy initiated by the Rhodesian Selection Trust being changed, but the whole question was, in any case, very debatable.

At the meeting a collection was made on behalf of the Royal Metal Trades Pension and Benevolent Society which yielded £15. This year's annual dinner/dance is to be held at Chadwick Manor Hotel on December 6, tickets 35s. each. Accommodation is limited to 200, and those wishing to attend should make early application to the Club treasurer, Mr. H. A. McGhee.

Furnace Relining at Margam

It is expected that the No. 2 blast furnace at the Margam Works of the Steel Company of Wales, Limited, will be back in commission at the end of this month. Work on the relining of the furnace began on June 10, when it was prepared for blowing out. The work is now well under way. Rebricking is expected to take about five weeks from the commencing date, and approximately 307,000 bricks will be used.

When the operation is completed the hearth diameter of the furnace will be increased from 25 ft. 9 in. to 27 ft. 3 in., which is expected to increase the output by upwards of 500 tons weekly.

Hot-tearing of Castings: A Review of the Literature*

By Professor R. A. Dodd

I. OCCURRENCE, CLASSIFICATION, AND IDENTIFICATION OF HOT-TEARS

When a casting solidifies and contracts under conditions that hinder the free contraction of part of the casting, "hot-tearing" or "hot-short cracking" of the metal is likely to occur. As the name implies, a hot-tear takes the form of a ragged tear or crack. It is found in both ferrous and non-ferrous materials, particularly steels and aluminium alloys, and is one of the most common as well as one of the most serious defects encountered in foundry practice.

Hot-tears have been classified [1, 2, 3, 4] into internal and external types, the principal justification for this division being that it was formerly thought[4] that internal tearing occurred at higher temperatures than did external tearing. Internal tears were assumed to develop during solidification, and external tears to develop after solidification. It is now known that this is not true, the difference in the two types being purely one of location in the casting.

Internal Tears

Internal tears occur at, or near, the centre of relatively heavy sections, *i.e.*, in the portion of the casting which solidifies last. The solidification of a heavy section proceeds by progressive inward freezing from the mould walls, and in the final stage of solidification the opposite sides of the contracting metal case are separated by interdendritic pools and films of liquid metal. Further contraction before complete solidification may cause tearing in the centre of the section particularly in the absence of sufficient molten feed metal to compensate for solidification shrinkage. The conditions giving rise to internal tears are therefore similar to those resulting in interdendritic shrinkage cavities. Internal hot-tears usually consist of a multi-branched system of cracks radiating from one or more main tears. They do not normally extend to the surface of the casting, as the solid skin of the section has attained sufficient strength and ductility to prevent their propagation in an outward direction, and on this account they are difficult to detect except by X-ray and ultrasonic inspection techniques. Occasionally, tears extend nearly to the surface of the casting, and may then be revealed during machining operations. It will be seen that under these conditions no external restraint is required to cause the internal hot-tear, the constraint being built up in the casting itself.

External Tears

External tears are first formed at the surface of the casting and then proceed inward to a greater or lesser depth, depending on the severity of cracking. They are due to a variety of causes, all of which are associated with points of strain concentration in the casting. Consider a hot metal rod held rigidly at each end and allowed to cool; if a localized part of the rod is imagined to be weaker than the remainder of the metal, it is to be expected that the distortion consequent on the inability of the rod to contract freely will be concentrated in this region of weakest strength. In other words, a strain concentration develops at this point. A hot-spot is such a region of low strength, and it is for this reason that hot-spots are so frequently associated with hot-tears. For example, the junctions of thin and thick sections are frequent tearing sites: the thin section freezes more rapidly than the thicker one, and the bulk contraction of the solid metal causes tearing at the junction. The grossest forms of external tears are easily visible, but finer cracks—none the less structurally damaging on that account—may only be revealed by magnetic crack-detection, deep, etching, fluorescent-liquid penetrants, radiography, etc. External tears have also a characteristic, ragged appearance, often with minor off-shoots. They can usually be identified from other types of cracks by their location with respect to the design and expected mode of solidification of the casting, and by the fact that the tear tends to follow an intergranular path, as in Fig. 1. They may also show some discolouration of the fractured surface as a result of the high temperature of tearing, and this discolouration may distinguish them from cracks occurring spontaneously at lower temperatures.

II. THEORIES OF HOT-TEARING

Introduction

Although the causes of hot-tearing have been known in a general way for many years, considerable doubt has always existed as to the precise mechanism of tearing. Examination of a hot-tear reveals that rupture occurs when the metal is in a brittle condition, the metal adjacent to the crack being entirely free from plastic deformation (Fig. 1). Consequently, early theories postulated

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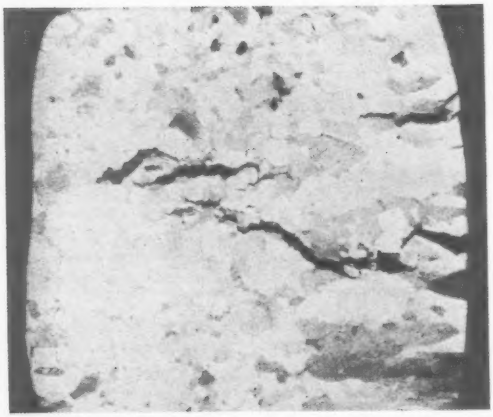

FIG. 1.—*Typical microstructure of a hot-tear showing the multi-branched intergranular cracks.*

a brittle structure of low-tensile-strength existing within a temperature range somewhere below the solidus, so that when a casting contracts under conditions of restraint, the stress induced may exceed the tensile strength and cause tearing[2, 4]. Variations in the hot-tear susceptibilities of different alloy compositions were assumed to be related to differences in mechanical properties at the temperatures of tearing and also to the extent of the temperature range in which brittle rupture was possible.

Thus, for a long time the problem appeared to involve merely load and strength within a critical temperature range, and a high proportion of investigations to date have been devoted to these aspects of the problem. Naturally, a majority of the researches have concerned steels and, presumably acting on the assumption that tearing is related to high-temperature properties that might well vary with steel composition, much of the work has dealt solely with variations in steel composition. As will be seen later, tearing is associated principally with rates of straining at temperatures above the solidus, and not with mechanical properties at some sub-solidus temperature. It is therefore not surprising that the effects of composition, over the more-or-less rigid specification limits normally laid down, are, with a few exceptions, of relatively minor importance. Furthermore, many of these researches—again because stress is measured rather than rate of strain—are marked by differences in the conclusions arrived at, and similar differences have always existed in the opinions of practical steelfounders. A typical illustration of this is the many different views that have been expressed on the effect of carbon content.

Temperatures

Attempts at determining the temperature at which tearing takes place have also given rise to considerable disagreement. This would appear to be related to difficulties due to the high temperatures involved, and criticisms of some of the methods of temperature measurement have been made[5]. The net result has been that considerable confusion has existed as to the precise mechanism by which tearing occurs, and as to the effect of different variables such as composition, pouring temperature, etc.

Work in the aluminium-alloy field has given a much more coherent picture, and for this reason it is convenient in this report to consider separately the experimental work on the hot-tearing of aluminium alloys and the experimental work on the hot-tearing of steels and cast irons, and then to discuss the general theory of hot-tearing that has been advanced in recent years and which fits the majority of known facts in both fields.

Hot-tearing of Aluminium Alloys

In conformity with the belief then existing (1914) that low mechanical properties at elevated temperatures were conducive to hot-tearing, an early attempt[6] at evaluating hot-tear susceptibility involved a solidifying casting which raised a weight; the weight being increased in successive

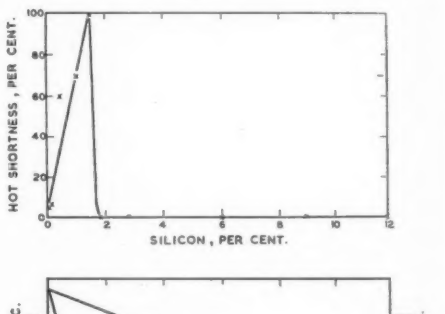

FIG. 2.—*Relationship between hot-tearing and alloy constitution of aluminium/silicon alloys, as determined by Veroe.*

experiments until fracture of the casting occurred. Charpy impact tests were later used in an attempt to evaluate the hot-shortness of various commercial aluminium alloys[7], but in all cases the resistance to shock remained high, right up to the temperature of incipient melting and then fell away rapidly. No evidence of any brittle sub-solidus temperature range was obtained, and subsequent investigations

have revealed that the majority of aluminium alloys rarely crack at sub-solidus temperatures.

Although it was known that pure metals and alloys which solidify at a constant temperature are not hot-short, and that the phenomenon is restricted to alloys which solidify over a temperature range (during which time they are in a pasty state), no significant contribution to the subject was made until the work of Veroe[8] who verified the futility of mechanical-property tests and related tearing to the eutectic content of the alloy. An examination of aluminium-rich aluminium/silicon alloys showed that tearing occurred at low-silicon contents with a maximum at 1.60 per cent. silicon. Further silicon additions reduced tearing considerably, and alloys containing in excess of 1.9 per cent. silicon were relatively free from tears. It was argued that in the presence of an appreciable quantity of eutectic, the alloy, immediately before complete solidification at the eutectic temperature, consists of a relatively large amount of liquid and relatively few crystals; if, therefore, any cracks do develop they are refilled with liquid eutectic forced there by hydraulic pressure. As eutectic solidification takes place at constant temperature, no contraction strains are set up and cracking is unlikely. In the case of alloys containing a smaller amount of eutectic, it would become increasingly difficult to force liquid eutectic into intercrystalline fissures, and at some limiting eutectic content the tears would not heal. Veroe calculated that 12 to 13 per cent. of liquid is necessary to heal cracks. Fig. 2 summarizes Veroe's results and relates them to the Al/Si equilibrium diagram.

Scheuer[9] found results similar to Veroe's and suggested that maximum susceptibility to tearing occurred at 1 to 2 per cent. eutectic in the alloy, while Bochvar[10, 11] estimated that 15 to 20 per cent. eutectic was necessary to avoid cracking in aluminium alloys, although this percentage varied from system to system. Lees[12, 13] confirmed that an important feature of alloy constitution is the proportion of eutectic or other low-melting-point constituents which separate out at constant temperature, and advanced a tentative theory to explain hot-tear formation. He suggested that during solidification, at a time when the primary crystals are too small to touch one another, the shrinkage, incorporating solid dendrite shrinkage and liquid shrinkage, is compensated by mass feeding of the casting. At a later stage, when dendritic growth and interlocking occurs, solid shrinkage will set up stresses if bulk contraction is restrained by any agency. This may produce a tear, particularly at local hot-spots where the network is less coherent, and especially if the temperature interval between the formation of a coherent network and the completion of solidification is long, giving a large bulk contraction effect[8].

Other Work

Veroe's work on the hot-tearing of aluminium/silicon alloys was carried a stage further by Singer and Cottrell[14], who determined the tensile properties in the region of the solidus of alloys containing up to 12 per cent. silicon. It was found that elongation and reduction of area fell to zero at the solidus temperature but that in the case of some alloys the tensile strength, although falling to a very low level, did not drop to zero until some temperature intermediate between the solidus and liquidus temperatures was reached. In other words, certain alloys possess a finite strength or coherence within a temperature range above the solidus while at the same time having negligible ductility. Extending Lees' reasoning, it seemed likely, then, that the extent of this brittle range above the solidus determines the general hot-short characteristics of an alloy. The greater the range, the greater would be the bulk thermal contraction in portions at a more advanced stage of solidification, and, consequently, the greater would be the likelihood of cracking. The more important results are incorporated in Fig. 3 which reveals that the hot-short range rises to a maximum at 1.8 per cent. silicon, so that alloys of this composition should be most susceptible to hot-short cracking. An explanation of the low-strength brittleness of the alloy at above-solidus temperatures resulted from further tests in which samples were subjected to microscopical examination following quenching from within this temperature range. These tests showed that an originally liquid silicon-rich phase had been present, partly as land-locked globules and—of much greater significance—partly as intercrystalline films. Thus,

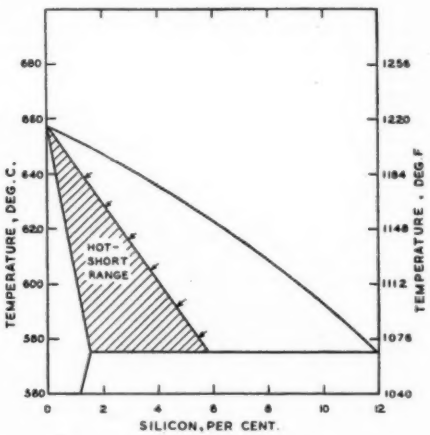

FIG. 3.—*Relationship between hot-short temperature range and composition of aluminium/silicon alloys as determined by high-temperature tensile tests (Singer and Cottrell).*

an alloy containing 1 to 2 per cent. silicon will contain, at a temperature just above the solidus, very little liquid phase and will retain some measure of coherency. The presence of these intercrystalline films will, however, cause the tensile strength to fall to a very low level. Furthermore, according to Veroe, the liquid will be unable to pass between the solid dendrites and so cannot assist in healing

incipient cracks. An alloy containing, say, 6 per cent. silicon will under similar conditions contain much more liquid phase so that coherency is much less marked. Cracking is therefore unlikely, but even if it should occur, liquid feeding of the tears is possible.

Further work[15] on the hot-shortness of aluminium/silicon alloys of commercial purity was conducted

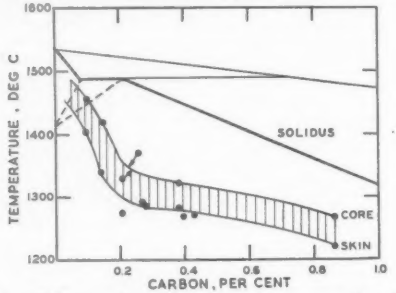

FIG. 4.—*Effect of carbon content on the high-temperature ductility of cast-steel test-pieces (after Hall). The shaded area represents the temperature of the test-bars giving 5 per cent. elongation.*

by casting alloys into cylindrical metal ring moulds and measuring the amount of cracking. The conclusion was reached that Veroe's observations concerning eutectic content of the alloy, although of great importance in many cases, is not entirely adequate in explaining all the observed facts, and that the extent of the hot-short temperature range discussed earlier constitutes the principal factor in determining the amount of tearing likely to occur.

Hot-tearing of Ferrous Alloys

In contrast to the results reported in the aluminium-alloy field, opinions of investigators have been divided as to whether or not hot-tearing of steel castings (in particular) is attributable to subsolidus cracking.

Koerber and Schitzkowski[16] investigated the contraction of steel bars in dry-sand moulds, and presented results suggesting that subsolidus brittleness did exist. The free contraction of straight bars was compared with others in which the contraction was (*a*) hindered by flanges at the ends of the bar, and (*b*) further hindered by steel rods moulded between these flanges. In all the tests, tearing was obtained when the contraction of the bars was impeded before the temperature fell to below 1,200 deg. C. and they concluded that the temperature range within which cracking was likely was 1,250 to 1,300 deg. C., *i.e.* some 150 to 200 deg. below the solidus. It was further observed that the fracture exhibited no plastic deformation, and the obvious conclusion was drawn that tearing must take place at temperatures when the steel has very little ductility. This absence of ductility they ascribed to the presence of small amounts of intercrystalline liquid, but this otherwise logical explanation did not quite correlate with their own observed temperature of tearing unless some constituents having a relatively low melting point are considered to be present. Briggs and Gezelius[4], working along similar lines, also concluded that tearing occurred around 1,300 deg. C.

This work was supported and extended by Hall[17] who carried out tensile tests on 1-in. dia. cast-steel tensile test-pieces at various times after pouring, *i.e.* during and after solidification. Low-carbon steels provided an exception to the general run of results, in that at 0.1 per cent. carbon or less, the bars were found to be ductile at above 1,400 deg. C., while their strength was less than 550 lb. per sq. in. In general, however, there appeared to be almost complete absence of ductility between the solidus and 1,300 deg. C., and no appreciable ductility until the temperature fell below 1,250 deg. C. Below 1,250 deg. C., the strength slowly increased, and usually exceeded 1,800 lb. per sq. in. before appreciable (5 per cent. elongation) ductility was recorded. Fig. 4 relates the iron/carbon constitution diagram to the temperature at which 5 per cent. elongation was obtained. These results suggest that low-carbon steels might be more resistant to tearing than medium-carbon steels, on account of their shorter brittle temperature range, but Hall remarked that this did not seem to correlate too well with foundry experience. However, available evidence now points to the fact that, although the effect of carbon content is a minor variable, low-carbon steels are somewhat more tear-resistant. It could not be, and was not, concluded from Hall's results that the hot-tearing of steel occurred at temperatures below the solidus, but the work did

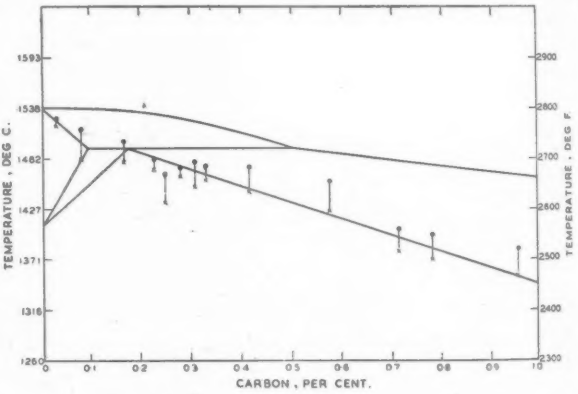

FIG. 5.—*Hot-tearing temperature range in steels as related to the iron/carbon equilibrium diagram (after Bishop, Ackerlind and Pellini).*

reveal that steels do possess low-strength brittle properties at sub-solidus temperatures, and that sub-solidus hot-tear cracking might under some conditions be possible. Other work[18] records a very steep drop in ductility from 100 per cent. to zero at around 1,200 deg. C., the precise temperature varying with composition. This is in rough agreement with Hall's results.

heated up from room temperature, showed that the eutectic melting point was always substantially exceeded before the bar broke under a constant load of 10 lb. per sq. in. At the temperature of eutectic solidification (1,130 deg. C.), a load of 81.5 lb. per sq. in. was required for fracture. These results then certainly suggested that mechanical interlocking of solid dendrites might be important in con-

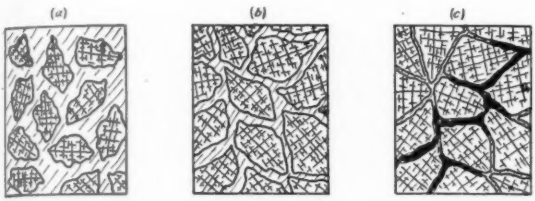

FIG. 6.—*Mechanism of film-stage tearing (after Pellini). Schematic representation of the solidification of a hot-spot under conditions of hindered contraction.*

(*a*) Solid nuclei together with considerable liquid metal. Hot-tearing is not possible at this stage.
(*b*) Crystals separated by thick liquid films. The stage when a "build-up" of strain in the hot-spot is possible is approaching.
(*c*) Stage just before complete solidification. Crystals are separated by thin liquid films. The developed strain concentration has been sufficient to cause hot-tearing.

Subsequent Work

Subsequent investigations vary somewhat in their findings, but, although the subject has remained a matter for considerable debate among foundrymen, distinctly higher tearing temperatures, ranging up to the solidus, have been quoted in more recent reports describing investigations employing refined experimental techniques. Bhattacharya, Adams and Taylor[19] place the tearing temperature of steel at somewhat above 1,360 deg. C., *i.e.* about 100 deg. below the solidus, the precise temperature varying somewhat with composition, while Middleton[20], employing a cast-steel bar restrained by a spring, found that the casting tore completely under a load of 55 lb. at a temperature of 1,488 deg. C. in the interior of the section. This latter temperature is 20 deg. above the solidus, indicating that at the time of rupture there would be about 16 per cent. of liquid steel in contact with 84 per cent. solid metal.

Cast irons are not normally prone to hot-tearing, but some attention has been devoted to this aspect of the properties of both grey and white cast iron. Hamaker and Wood[21] have determined the tensile strength of grey cast iron of 2.90 per cent. total carbon content, together with certain phosphorus and alloy additions, following direct cooling from the liquid state in sand moulds. Tests were conducted at temperatures within the range 900 to 1,120 deg. C., so that the upper limit of the range was little below the solidus temperature of 1,130 deg. C. These results indicated that liability to tearing, indicated by these high-temperature tensile-tests, varied to a considerable extent with the phosphorus content but was, in general, most pronounced in the range 1,035 to 925 deg. C., *i.e.* 100 to 200 deg. below the solidus. The tensile strength at the temperature of fracture ranged from 1,600 to 3,400 lb. per sq. in.

In the case of white cast iron, tests have been conducted on the tensile strength of this material above and below the solidus temperature[22] and on the actual temperature of hot-tearing of a test casting[23]. The tensile tests, conducted on specimens tributing to strength at temperatures above the solidus, and also that the dendrites themselves have quite high strength at these temperatures. The results of a hot-tear test casting indicated a tearing temperature of around 1,110 deg. C. This is only slightly below the solidus, and the authors themselves say that all their data indicate that tearing seems to occur at, or slightly above, the solidus temperature during the later stage of eutectic solidification and prior to complete solidfication at the location of tearing.

Strain Theory

The suggestion that hot-tearing represents fracture through liquid regions existing at near-solidus temperatures was originally implied by Koerber and Schitzkowski[16] who could at that time advance no proof of their contention. The review in the foregoing sections shows, however, that the later work of Veroe[6], Lees[12], and Singer and Cottrell[14] (in particular) established that the hot-tearing of aluminium alloys, at any rate, occurs at temperatures when interdendritic pools and films are present, and that there is also some evidence that a similar mechanism is operative in the case of steels. Further imposing evidence that this is in fact the case is due to the comparatively recent work of Pellini[5] and his associates[24], who developed their strain theory of hot-tearing based on a concept of liquid films existing at grain boundaries at temperatures above or in the region of the solidus. The experimental work on which the theory is based involved a determination of the temperature of tearing by X-ray examination of flat-plate castings at intervals following pouring. Accurate temperature determinations were made, and the time of the first indication of tearing on the radiograph correlated with temperature. Fig. 5, which gives the hot-tearing temperature ranges for steels of various carbon contents, shows clearly that tearing invariably starts at a temperature slightly in excess of its solidus; similar results were obtained for an aluminium/4 per cent. copper alloy.

If hot-tearing does occur at a time when the solid

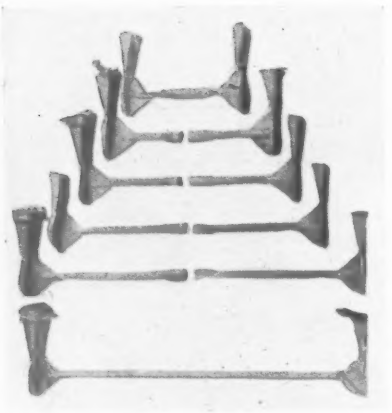

FIG. 7.—*Effect of strain concentration at a hot-spot in promoting tearing.* (*Hall.*)

If there is no hot-spot, the casting does not fracture. If there is a hot-spot, the casting length determines the strain developed in the hot-spot and, therefore, whether or not the casting will break.

dendrites are largely separated from one another by liquid films, it follows that the mechanical strength at this time will be virtually zero. Methods of ascertaining hot-tear susceptibility based on load-bearing capacity would then be valueless and this is the point of view Pellini adopts in his criticisms of these methods. Briefly, the theory puts forward the suggestion that tearing is related to the rate of straining in the region of the tear at a time when the metal is in the liquid-film stage. The films first developed as the metal falls to a temperature within the liquid-film region are relatively thick and capable of absorbing strains imposed by the contraction of any part of the casting that may be solid. At a later stage the films are thinner and the strain concentration in the films increases greatly; this is when hot-tearing is likely to occur. Fig. 6 illustrates schematically the mechanism of film-stage tearing.

Fig. 7 shows the hot-tearing of flanged bars of different lengths containing a hot-spot, illustrating the effect of high strain-concentration in promoting tearing. Solidification of the bar occurs before solidification of the hot-spot and, as solid contraction of the bar is hindered by the flanges, the strain tends to be concentrated in the hot-spot. Tearing cannot occur until the film stage is reached, but at this time the total contraction is naturally concentrated in the liquid films as being in the regions of least strength. The longer the bar, the greater the contraction and hence the greater the strain concentration in the films which, at a certain critical value of straining, will rupture. It has already been indicated that various workers realized the importance of liquid films without (apparently) appreciating the importance of strain concentration. Hall[17], on the other hand, realized the implications of strain concentration without suggesting that rupture occurred through liquid films.

Pellini discusses the work of Middleton and Protheroe[25] who attempted to assess hot-tear susceptibility by loading the solidifying casting through a spring arrangement. These workers observed that weak springs, *i.e.* large deflection, failed to cause tearing of the test casting. In terms of the liquid-film hypothesis, this is taken as meaning that the weak spring absorbed a considerable proportion of the strain. When fracture did occur when the weaker springs were used, it took place at higher loads and lower temperatures than when stiffer springs—which always caused tearing—were used, this fact being explained by the stiff spring forcing all the strain into the hot-spot, so giving a very high strain-concentration and early fracture. Briggs and Gezelius[26, 27] observed analogous effects when using springs of various strengths in similar tests.

Further Explanations

First appearances suggest that all metals and alloys are hot-short since they all pass through a liquid-film stage during solidification, and yet this is not observed in practice, as is evidenced by the work of Veroe[8], Lees[12], Singer and Jennings[15], and others. Pellini, in an explanation of this fact, contends that alloys which do not exhibit hot-shortness pass through the liquid-film stage in a very short time, and that a prerequisite of hot-shortness is the presence of low-melting-point grain-boundary constituents or segregates, permitting the liquid-film condition to persist for a time measured in minutes rather than seconds. Accordingly, rates of contraction which do not give a sufficient concentration

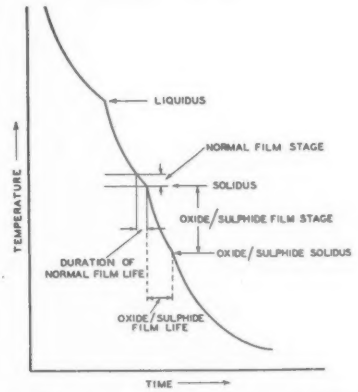

FIG. 8.—*Effect of sulphur on hot-tearing, as explained by the liquid-film hypothesis* (*Pellini*).

of strain in the hot-spot in a few seconds, may result in sufficient strain concentration to cause tearing when they are operative for minutes. Pellini explains the well-known effect of high-sulphur content in promoting hot-tearing in steel castings on the basis of the above reasoning, and obtained confirmation of the theory from further experimental work which revealed that high sulphur (and phos-

phorus) contents produced tears in the test casting at 28 to 42 deg. C. below the solidus on the Fe/C diagram. In other words, the effect of the high sulphur content is to increase the temperature over which the film stage exists, as shown in Fig. 8.

A similar argument can be developed to account for the observations of Singer and Jennings[15] on the hot-tearing of aluminium/silicon alloys, which

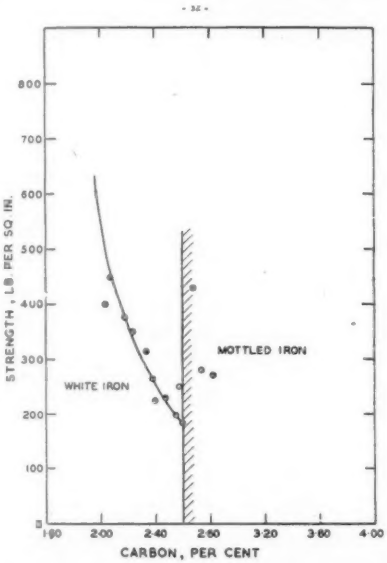

FIG. 9.—*Variation of hot-tearing with carbon content of white cast irons* (*Lange & Heine*). *Tearing expressed in terms of stress required to rupture test-bars.*

is really a rational development of their "supra-solidus brittle range" theory, discussed in an earlier section. Thus, an aluminium/1 per cent. silicon alloy contains no eutectic on solidification, and the life of the liquid-film stage is too short to allow sufficient strain concentration to develop and cause cracking. At higher silicon contents, eutectic will appear, and it is reasonable to suppose that maximum susceptibility to tearing will occur when sufficient eutectic is present to provide a continuous liquid grain-boundary network which will exist for an appreciable time over a temperature range extending from somewhere above the solidus down to the temperature of eutectic solidification. Maximum cracking occurs at 1.8 per cent. silicon, but an attempt by Singer and Jennings to correlate this fact with the appearance of eutectic in the solid alloy was unsuccessful, although the maximum solubility at the eutectic temperature is 1.65 per cent. Si. Possibly more elaborate micrographic techniques might reveal its presence.

In a consideration of the theories of Pellini *et al.*, Caine[28, 29] re-interprets work of Hall[17], Middleton and Protheroe[25], Lange and Heine[23], Brinson and Duma[30] (on bore cracks in flanged fittings), and Lillieqvist and Fuqua[31] (effect of slot-gate width on tearing), and shows how apparently divergent results are explicable on the basis of the strain theory.

Lastly, mention must be made of the fact that agreement on the precise mechanism of hot-tearing is not quite final, as is evidenced by a recent paper by Patterson[32]. Patterson considers that during the solidification of solid-solution alloys, deep channels of liquid metal are formed between the growing dendrites which, if later isolated from the liquid feeding metal, form interdendritic cavities. These holes act as "stress-raisers" and produce cracks during subsequent cooling of the casting.

Although Pellini considers that shrinkage may cause more severe tearing than would have occurred in shrinkage-free castings, the use of the term "stress-raisers" by Patterson implies that tearing occurs through solid metal, which is a fundamentally different assumption from that of Pellini. Weight of evidence suggests that Patterson's views are incorrect.

III. EFFECT OF COMPOSITION

(1) Aluminium Alloys

The work of Veroe, Lees, and Singer and Jennings on the variation with composition of the hot-tearing of aluminium-silicon alloys has already been considered, and the conclusion drawn that the most susceptible compositions are those in which a small quantity of eutectic is present as grain boundary films during solidification, resulting in increased life of the liquid-film stage. Smaller amounts of eutectic will decrease the film life, making impossible the development of sufficient strain concentration, while larger amounts of eutectic will be capable of absorbing contraction strains in spite of the fact that liquid-film life is increased. Thus, tearing rises from zero for the pure metal to a maximum approximately corresponding to the first appearance of eutectic, and thereafter decreases again as the eutectic content further increases. Other binary aluminium alloys show like trends[33] which are related to similar constitutional features, and some important ternary aluminium alloys have been investigated[34, 35, 36] and show similar results.

(2) Steels

A considerable volume of work has been devoted to assessing the importance of steel composition, but a survey of the literature reveals that within the usual specification limits, composition variations are comparatively unimportant with the exception of sulphur and (possibly) phosphorus content. The principal findings are:

Sulphur.—It is well known that unduly high-sulphur contents promote tearing in carbon and low-alloy steels[19, 25, 37, 38] and in austenitic manganese-steel[39]. Ellis[3] has reviewed the effect of sulphur and remarks that its tendency in promoting tearing arises from two causes: (*a*) an increase in

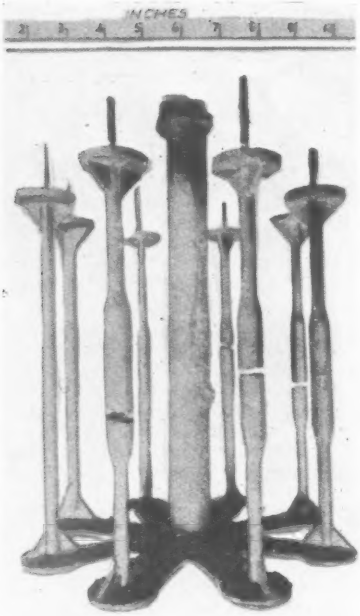

FIG. 10.—*Flanged-bar hot-tear test originated by Hall*[37].

manganese-sulphide inclusions, and (*b*) the production of complex oxide-sulphide inclusions of low melting-point, occurring as interdendritic networks. The second of these defects is much the more marked for obvious reasons, and the importance of maintaining a sufficiently high manganese content to ensure conversion of sulphur to manganese-sulphide is well known.

Phosphorus.—The most comprehensive report on the effect of phosphorus is that by Middleton and Protheroe[25] who report that phosphorus from 0.035 to 0.09 per cent. is of minor importance, provided ordinary pouring temperatures are not exceeded, but at higher pouring temperatures the higher phosphorus compositions tend to be more susceptible to tearing. Hall[17] found that high-phosphorus steels possess very low strength and ductility at slightly sub-solidus temperatures, suggesting that their resistance to tearing is inferior, and Gardom[39] found that a high-phosphorus content greatly increased the hot-tear susceptibility of Hadfield's manganese-steel.

Carbon.—The effect of carbon was for long a controversial matter, largely due to it being a relatively minor variable, but although Gelperin[40] and Singer[41] report that high-carbon steels are more tear-resistant, a majority of investigators find that lower carbon compositions tend to tear off less readily[25, 38, 39, 42, 43].

Titanium and Vanadium.—These elements have been found to be beneficial[25], the effect probably being related to their grain-refining properties.

Aluminium and Silicon.—It has been observed that the nature and distribution of sulphide inclusions in cast steel are dependent on the degree of deoxidation, and that the nature of the inclusions, *i.e.*, whether or not they tend to form grain-boundary films, is related to the extent of aluminium deoxidation[44, 45, 46, 47, 48]. This has been discussed in detail by Sims and Dahle[45], who concluded that an excess of aluminium over that required for complete deoxidation is beneficial in giving randomly distributed rather than intergranular inclusions. Later work[25] verified that aluminium is beneficial, if introduced in an amount sufficient to prevent grain boundary inclusions. Silicon-deoxidized steels tend to be susceptible to tearing, but it appears that aluminium additions to silicon-deoxidized steels counteract the deleterious effect of silicon[19].

Nickel, Chromium, Molybdenum, etc.—All these exert a negligible effect[37, 25].

(3) Grey and White Cast Iron

Grey cast iron is normally resistant to tearing, but the work of Hamaker and Wood[21] suggests that phosphorus content can influence tear susceptibility. This is a reasonable conclusion, as the binary and ternary phosphide eutectics occur as interdendritic aggregates and can be considered to act in a similar manner to boundary sulphides in steel. The tearing tendency of plain grey irons was not found to increase appreciably until the phosphorus exceeded 0.16 per cent., but alloy irons showed a marked increase in susceptibility when the phosphorus was increased from 0.04 to 0.07 per cent. Molybdenum and chromium additions were particularly effective in improving resistance to hot-tearing, by segregating in the phosphide eutectic and increasing its volume.

The tearing of white-iron castings is likewise not normally a serious foundry defect, but the subject has been studied by Lange and Heine[23], whose results, shown in Fig. 9, are chiefly of interest on account of their lack of conformity to the general principles arising from the work of Veroe and later workers in the light-alloy field and the recent work of Pellini and his associates. Thus, an increase in carbon content, *i.e.*, an increase in eutectic content, results in a steady diminution of the resistance to tearing up to that carbon content at which mottling starts to occur. This is an interesting observation as the eutectic content of all alloys examined should normally be sufficient to completely inhibit tearing. These results were explained by Lange and Heine as follows: At lower carbon-contents, much more solid metal forms prior to eutectic freezing than solidifies in the higher-carbon irons, as is evident from a consideration of the iron/carbon equilibrium diagram. This solid metal, formed before eutectic solidification, determines the strength of the matrix developed before the normal temperature range of hot-tearing (immediately above temperature of eutectic solidification) is reached. In other words,

they imply that mechanical interlocking of austenite dendrites at temperatures above the solidus is of paramount importance in determining the tear resistance of white iron. However, they do not comment on the fact that under the conditions of their test no eutectic feeding of tears was possible. It therefore seems unrealistic to attempt to translate the observations to foundry practice, when feeding would almost certainly be possible.

Other work[22], mentioned earlier, showed that austenite/liquid mixtures do not have quite appreciable strength, and that the eutectic melting temperature was always substantially exceeded before a white-iron, tensile test-specimen broke under a constant load of 10 lb. per sq. in. It appears then that Pellini's theory is not quite of universal application, as there seems to be no reason why mechanical interlocking should not be of importance in other alloy systems.

(4) Magnesium Alloys

Magnesium alloys do not have the reputation of being particularly prone to hot-shortness, and there is therefore little literature on the subject. Foundry experience has, however, shown that certain compositions do tend to crack rather more readily than others, and Eastwood *et al*[49] have examined some compositions in the Mg/Al/Zn system, finding that the alloy AZ63 (6 per cent. Al, 3 per cent. Zn) is slightly more susceptible than other commercial alloys in this system. The effect of 1.25 per cent. rare-earth additions to alloy ZK51 (4.5 per cent. Zn, 0.6 per cent. Zr) is to increase its eutectic content, and use has been made of this fact in reducing its tearing tendency[50]. Appearances suggest that the general principles governing the hot-tear behaviour of aluminium alloys are equally valid for magnesium alloys. The hot-tearing of magnesium alloys is at present the subject of an investigation in the Physical Metallurgy Division of the Mines Branch (of the Author's Department) and will receive detailed consideration in later reports.

IV. OTHER FACTORS AFFECTING INCIDENCE OF TEARING

(1) *Effect of Mould Variables*

A very high percentage of hot-tears can be ascribed to the effect of the sand mould and cores in hindering contraction, and the importance of this subject is such that it cannot be adequately discussed within the confines of the present review. In any case, the general principles governing the influence of the mould on tearing are well understood and have been reviewed in numerous publications.[2, 3, 4, 16, 59] Middleton[20] has recently made a comprehensive investigation into the effect of moulding materials.

(2) *Gas Content of Liquid Metal*

Gas content has been the subject of an investigation by Lees[60], who studied different aluminium alloys and found that the effect of dissolved gas was to reduce tearing in those alloys which have a relatively high eutectic content. The explanation is that hydrogen rejected from solution during solidification sets up an internal pressure sufficient to force liquid eutectic into incipient tears. In the case of normal gas-contents, the effect is small in comparison with other variables, but when considerable pinhole porosity can be tolerated, as for example in many aluminium permanent-mould castings, the effect of a high hydrogen content in inhibiting tearing is very appreciable. The practical implications of this effect have been discussed at length by Scheuer *et al*[67].

(3) *Grain Size*

The fact that fine-grain castings are relatively free from tears as compared with those of coarse-grain is a well-recognized foundry fact and was investigated by Lees[32]. Middleton and Protheroe[25] have remarked on the beneficial effect of titanium and vanadium additions to steel, and there seems to be no reason to doubt that this is due to a grain-refining effect. Cibula[61] explains the effect of grain size on the basis of the " coherent temperature range " observed by Singer; a ready explanation[5] is provided by the strain theory.

(4) *Microporosity (in magnesium alloys)*:

Goddard[62] has concluded that tear cavities, if formed, are readily distinguishable from microporosity cavities, and his evidence suggests that

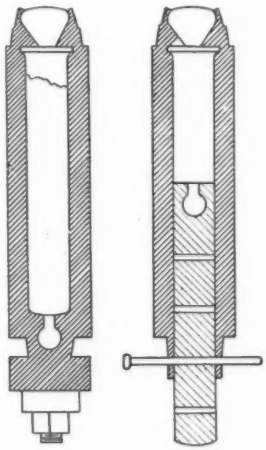

FIG. 11.—*British Non-Ferrous Metals Research Association's hot-tear test (Lees), as improved by Tatur (steel mould).*

the presence of microporosity does not necessarily contribute to the incidence of tearing.

(5) *Mould Friction*:

According to Andrew and Protheroe[63], mould friction (investigated by employing sands of different degrees of coarseness) does not exert any influence on the susceptibility to tearing. This conclusion does not seem entirely in accordance

with the work of Parkin and Cowan[64] who, having found that residual stresses can be controlled to some extent by using facing sands of certain grain-size distributions, comment that their results appear to be due, in part, to the frictional characteristics of the sands. If sand friction is in fact sufficiently marked to affect internal stresses, it would perhaps be expected that it might under some circumstances provide the necessary restraint to contribute to tearing.

(6) *Melting-furnace Atmosphere*:

This has been the subject of tests[65] which indicate that hydrogen and carbon-monoxide atmospheres do tend to improve the resistance of white iron to tearing.

V. METHODS OF ASSESSING SUSCEPTIBILITY TO HOT-TEARING

Various methods have been used to assess the susceptibility of different alloys to hot-tearing. The first type involves measuring the stress required to rupture a test casting during or after solidification,[6, 23, 25, 26, 51] or, in some cases, determining the tensile strength at elevated temperatures.[21, 22] Such methods have yielded much useful information, as is typified by the work of Briggs and Gezelius[26], Middleton and Protheroe[25], and Lange and Heine[23], but, in the light of the strain theory of hot-tearing, their use does not seem logical and may in certain circumstances give misleading results[28, 29].

Other methods involve the contraction of cylindrical bars of different diameters with flanged ends to restrain their free contraction.[52, 53] The purpose of the varying diameter of the bars was apparently to alter the stress developed in them, and it seems doubtful whether these investigators, in common with those mentioned in the preceding paragraph, appreciated the importance of strain concentration. Alternatively, the free contraction was restricted by cast-in threaded steel rods[53] attached to the rigid ends of the moulding box or by steel restraining rods moulded between flanges at the ends of the test-pieces.[54, 19]

Methods involving casting flat rings around sand or metal cores have been quite widely used.[15, 36, 50, 55] It is not easy to visualize a logical basis for this test, but the method has been used with particular success by Singer, Jennings and others of Birmingham University, and also in modified forms[36, 56] by subsequent workers elsewhere. In one version of the test (Singer *et al.*) the total length of the cracks is taken as a measure of the hot-shortness.

The most logical tests—again basing the reasoning on the strain theory of tearing—are those employing test castings, sometimes of quite an elaborate nature, in which the strain arising from the solid contraction of a portion of the casting is concentrated in a narrow hot-spot. The hot-spot may be at the junction of the runner[30, 57] or riser with the casting, or, more commonly, at the junction of different sections.[8, 19, 24, 66] The majority of these tests do not, however, permit an easy alteration of the strain applied to the hot-spot, and it is necessary to assess the severity of tearing by visual estimation of the length, width and extent of the cracks. From purely theoretical considerations, it is the writer's opinion that the best test yet developed is that due to Hall[67] (see Fig. 10), and later selected by Briggs[1] as the best available, which employs flanged bars of different lengths containing a hot-spot of constant dimensions in the middle of the bar. The solid contraction of the bar (the extent of which is determined by its length) is restricted by the flanges, and the resulting strain concentrated in the hot-spot may or may not cause cracking (*e.g.* Fig. 7). The minimum length of bar required to cause cracking is a measure of the hot-shortness. It is true that the reliability of this test is upset if the ramming density, sand composition, etc., cannot be held constant. Lees[12] comments adversely on the test for this reason, and it is possible that better consistency might result from the use of metal or ceramic moulds.[9, 56, 58] Tatur's modification[56] (Fig. 11) of Lees' original design[53] is an attractive, simple method and appears to work well, but it suffers from the apparent disadvantage that it does not include a hot-spot.

Another basically similar method, devised by Bertram *et al*[66], employs a test casting consisting of a basin with a rim of varying thickness. Cracking tends to occur at the junction of the basin and rim in the region where cross-sectional differences are greatest, and to extend around the junction to an extent depending on the hot-tear susceptibility of the alloy. The crack length is therefore a measure of hot-shortness. The use of a metal mould overcomes the above-mentioned deficiencies associated with sand moulding, but the authors' published results, relating to the influence of silicon, copper, zinc and magnesium on the hot-shortness of Al/6 per cent. Si/3 per cent. Cu alloy suggest that reliable results necessitate averaging the crack lengths from at least 5 to 10 castings. However, the use of a permanent-mould casting-technique makes this easily possible.

Unfortunately, all methods using permanent moulds suffer the disadvantage that the rate of cooling is greater than in sand moulds. This in turn affects such factors as grain size, mass feeding, rate of straining, time during which liquid metal films are in existence, thermal gradients, etc., all of which are important to hot-tearing. Thus the results obtained may not be applicable to large sand castings.

Acknowledgment

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Study of Soviet Training

Engineering education and training in the Soviet Union are to be studied by a British engineering delegation, which left London on Sunday. The group is led by Prof. E. Giffen, Professor of Civil and Mechanical Engineering in London University, and the nine members of the delegation have been nominated by the Joint Committee of the Institutions of Civil, Mechanical, and Electrical Engineers. The visit is under the auspices of the Soviet Relations Committee of the British Council, and a return visit to the United Kingdom by a group of Soviet experts is being considered.

With Prof. Giffen will be:—Mr. W. K. Brasher, secretary of the Institution of Electrical Engineers; Dr. B. N. Cole, senior lecturer in mechanical engineering, Birmingham University; Mr. H. E. Dance, HM Inspector of Schools (Technical Branch); Dr. H. L. Haslegrave, principal of Loughborough College of Technology; Mr. G. S. C. Lucas, a director and chief electrical engineer of the British Thomson-Houston Company, Limited, Rugby; Mr. P. E. Sleight, Brighton Technical College; Mr. E. G. Sterland, of Bristol Aeroplane Company, Limited, and Prof. A. S. T. Thomson, from the Royal Technical College, Glasgow.

Company News

A. REYROLLE & COMPANY, LIMITED—An interim dividend of 6¼ per cent. in respect of 1956 represents an average of ¼ per cent. For the previous year, a final dividend of 10 per cent. made a total of 16¼ per cent., against 15 per cent. for 1954.

LARMUTH & BULMER, LIMITED, engineers, of Salford (Lancs)—The directors recommend acceptance of an offer of 35s. per 10s. ordinary share made by Mono Pumps, Limited, which has declared its intention of carrying on the business under the same name and with the same policy.

CHAS. CARR, LIMITED, non-ferrous founders, of Smethwick—Net profit for the year to June 30 was £17,905, against £18,413. The year was made difficult by erratic movements in the metal markets, the chairman, Mr. D. Campbell, reports. Over the last 10 years annual turnover has risen by 600 per cent.

ACROW (ENGINEERS), LIMITED—The net profit for the year ended March 31 was £253,631, compared with £228,996. A final ordinary dividend of 15 per cent., making 35 per cent., is recommended. The chairman states that output is running at 23 per cent. above last year. More than 50 per cent. of the company's production is exported.

RUBBER IMPROVEMENT, LIMITED—A final dividend of 40 per cent. on the ordinary and "A" ordinary capital is announced, making 100 per cent., or an effective rate of 94 per cent. allowing for the 25 per cent. scrip issue between the two interim dividends each of 30 per cent. Group trading profits for the year ended May 31 rose from £514,350 to £918,487. Tax is £411,618, against £201,770.

RUSTON & HORNSBY, LIMITED—The chairman, Mr. W. J. Ruston, reported at the annual meeting that output for the first four months of the year showed a very substantial improvement. Some large orders have been received for gas turbines from Middle East oil companies and America, and orders for large marine engines to a total value of more than £500,000 also had been secured.

TATA IRON & STEEL COMPANY, LIMITED—At the annual meeting in Bombay on August 30, Mr. J. R. D. Tata, the chairman, reported a fall of £225,000 in the disposable profit, largely due to lower sales of ferro-manganese and the large accretions, exceeding £3,000,000, to the plan rehabilitation and development fund and the development reserve under the Indian Government's new retention price scheme.

DELTA METAL COMPANY, LIMITED—The company announces that negotiations for a merger of the interests of Mansill, Booth & Company, Limited, Smethwick, and Elkington & Company, Limited, Walsall, with those of Delta Metal have reached an advanced stage. Mansill, Booth & Company manufactures hot brass pressings and stampings, while Elkington & Company carries on the work of copper refiners, silversmiths, electroplate manufacturers, etc.

WARNER & COMPANY, LIMITED—Sales of refined and alloy pig-irons were the highest ever recorded and are not likely to be exceeded without further additions to plant, the chairman, Mr. D. O. Sillars, states. These are not contemplated at the moment; present indications show some reduction in demand, particularly from foundries associated with the automobile industry. The net profit for the year ended June 30 was £54,878, compared with £36,413. The ordinary dividend is raised to 22½ per cent. from 20 per cent., allowing for the one-for-one capitalization issue last March.

New Patents

(Copies of complete specifications are obtainable from the Patent Office Sales Branch, 25, Southampton Buildings, Chancery Lane, London, W.C.2, price 3s.)

752,833. Compagnie Generale des Conduites D'Eau, 1, Quai des Vennes, Liege, Belgium.

Improvements in machines for centrifugal casting of objects. The invention is intended to overcome the difficulties of obtaining quality and uniformity upon which are dependent physico-chemical and thermal factors of which known automatic machines take no account.

753,163 and **753,164.** D. B. Alexander, J. H. Chamberlain, J. F. Manion, W. A. Wade, E. R. Bourke, E. W. Schneider, C. S. Vrtis, and L. J. Gary, all of 1830 South 54th Avenue, Chicago, Ill., USA.

753,163 deals with a method of covering sand grains with individual coatings of solid, non-tacky, potentially thermosetting resin. The sand is mixed with a thermoplastic phenol-formaldehyde resin and with an amount of hexamethylene tetramine sufficient to ultimately convert the resin to the thermosetting condition, while the mixture is in a heated condition. This will uniformly coat the sand grains with resin in liquid or melted condition. The mixture is cooled after partial reaction of hexamine with the resin, to below its resulting modified melting point to arrest further conversion reaction and to solidify the resin coating on the grains. Mixing during cooling to solidification is continued to separate the aggregates in the mix. **753,164** claims a free-flowing storage-stable, dustless, non-tacky sand coated with thermosetting resin material and a solid outermost coating of waxy material.

753,228. Rolls-Royce, Limited, Nightingale Road, Derby.

A method of forming a mould for the precision casting of metal which includes addition of an aqueous solution of sodium or potassium silicate or a mixture thereof to an excess of an aqueous solution of mineral acid. With the acid reaction-products so formed, are mixed a stable, substantially electrolyte-free colloidal dispersion of silica in water. The resultant liquid is used to bind a refractory mould material.

Contracts Open

The dates given are the latest on which tenders will be accepted. The addresses are those from which forms of tender may be obtained. Details of tenders with the reference ESB can be obtained from the Board of Trade Export Services Branch, Lacon House, Theobalds Road, London, W.C.1 (telephone: CHAncery 4411, ext. 738 or 771), unless otherwise stated.

BRAZIL, September 28—Oil-firing equipment for dredgers, for the Departamento Estadual de Portos, Rios a Canais. (ESB/22651/56.)

BURMA, October 4—Oil testing equipment, for the Union of Burma Purchase Board. (ESB/22546/56.)

BURMA, October 8—Electric motors, for the Union of Burma Purchase Board. (ESB/22783/56.)

FORMOSA, October 4—Machine tools, etc., for the Central Trust of China, Purchasing Department. (ESB/22434/56/ICA.)

FORMOSA, October 5—Heat-treatment units, electric drills, etc., for the Central Trust of China, Purchasing Department. (ESB/22987/56/ICA.)

Board Change

E. K. COLE, LIMITED—Mr. A. J. Brunker, the chief engineer, has been appointed an executive director of the company. In 1953 he was appointed a director and general manager of Ekco Electronics, Limited, the wholly owned subsidiary.

Application of Insulated Feeders to Sand Castings in Long-freezing-range Copper Alloys*

Discussion of the Paper by Mr. R. S. Jackson, B.Sc.

Initially, the Chairman stressed the important effect of good feeding on yield and thus on the economics of founding. Questions and replies then dealt with the apparent conflict of high- or low-temperature pouring when good feeding was sought; where chills should be placed; the balance between plaster and exothermic material. An important reaction from a practical foundryman is reported. Subsidiary matters discussed concerned the heat-conductivity of CO_2-bonded sand vis à vis *exothermic material and plaster, and the possible use of vibration, breaker cores and pre-ignited sleeves for feeding.*

Opening the discussion, the CHAIRMAN (MR. J. BLAKISTON) said the Paper was a very practical one in many ways. Apart from the non-ferrous aspects which were covered specifically, it had been found in practice, in grey-iron, steel and light-alloy manufacture, that the yield per melt could be increased by 10 per cent. or more by the use of exothermic feeding heads, which had a very marked influence on the foundry operating profit or margin of profit because, after all, a large proportion of the manufacturing costs were absorbed in melting and preparation of metal. Therefore, in submitting the Paper for discussion, he emphasized its importance from the point of view of the economic working of foundries.

Contradictory Requirements?

MR. G. W. BURGER commented that the Paper put forward the most anti-"riser" theory he had ever heard, and would suggest that its title might be "How to make small castings in slow-freezing alloys without the use of feeders." It seemed the Author had advocated that for small castings in 85/5/5/5 alloy founders should use no feeders, or at any rate as few and as small feeders as possible. However, there was the question of casting temperature and solidification. It seemed that one should cast at the slowest rate feasible—needing a high casting temperature, and hope that the metal would solidify practically as it was cast—which would mean low casting temperature. He, Mr. Burger, had always assumed that, once an alloy was solidifying and got into the pasty range, normal freezing took place, and that feeding as such was only possible when the metal was in the fully liquid state. In the slow-freezing alloys, as the Author said, there would be parts which were pasty and parts which were still liquid. In a small casting, surely the pasty mass would interfere with the flow of the liquid mass to a greater extent than in a large casting. Hence, if there were no adequate feeders to provide extra liquid metal, porosity due to unfed shrinkage would result.

MR. JACKSON said he had mentioned that pouring temperatures were about 1,130 deg. C., which was over 100 deg. above the melting point of the metal. However, the temperatures actually recorded on a high-speed recorder connected to the small thermo-couples in the mould cavity, he believed he was right in saying, never exceeded 1,050 deg. In no case was the metal temperature within the casting cavity very much above the melting point of the metal.

With regard to feeding during the pasty range, mass feeding could take place, provided that the metal in the feeder was sufficiently fluid to be able to exert hydrostatic pressure, and provided that the metal inside the casting cavity also was sufficiently fluid to transmit that hydrostatic pressure throughout the casting.

DR. J. T. BERRY (Royal Naval Scientific Service, N.C.R.E., Dunfermline), in the light of the recent paper by Basil Gray†, who had advocated putting a chill in the top of a normal head on sand cast ingots, asked whether founders could take the argument further and put a chill also in a small head; the idea of the chill being presumably a source of crystallization to further the so-called nuclear deposition. How far did Mr. Jackson think nuclear deposition occurred in non-ferrous alloys, and would he go so far as to put on a chill?

Secondly, he suggested Mr. Jackson had neglected the end effects in saying that solidification time did not change much in the experiments. Taking into account the top and effect and neglecting the heat influx through the lower end, Dr. Berry had found there were differences of about 200 per cent. in the calculated solidification time. Could Mr. Jackson confirm that?

MR. JACKSON said the main variation from the constant relationship between the volume and the surface-area occurred with the very small feeders of perhaps 1-in. high, where the disc at the top and at the bottom were large compared with the curved area of the feeder. In fact, in the work of temperature recording he had not noticed any significant difference.

In regard to the use of a chill, he was not familiar with the paper referred to by Dr. Berry and he was not certain whether one would put the chill in the feeder. The main significance of chills generally in castings was to induce a higher temperature gradient within the mass. He would have said the chill should be put on the bottom, not on the

* Paper presented at the Cardiff Conference of the Institute of British Foundrymen and printed in the Journal, June 21, 1956.

† B. Gray, *J.I.S.I.*, 56 (p. 4, April), 182, 366.

feeder at all, and that founders might by that means achieve porosities below 2½ per cent. It would not alter the mass feeding to any great extent, but would ensure the high temperature gradient towards the end of the freezing, when the remaining feeding took place by the passage of low-melting-point constituents through the inter-dendritic spaces.

Casting Temperature

MR. A. CIBULA said that casting temperature was important, of course. Mr. Jackson had suggested that one need not use a feeder on small castings, but he had not said that there would then be no porosity; he had simply said that the porosity was not generally important enough to make the use of a feeder economic. All the same, there would be some porosity, and this would reduce pressure tightness if its distribution were not controlled. Porosity had the least effect when it was at the centre of the section and to achieve this one tried to make the macrostructure columnar. In order to get a columnar structure it was necessary to use a sufficiently high casting temperature.

MR. JACKSON said he had stated that the temperature within the casting was about 1,050 deg. C., and that was insufficient to produce a columnar structure. If a higher temperature were used they might have produced a columnar structure.

MR. H. G. HALL said the inference of the Paper was that the long-freezing-range alloys needed very little feed metal; but if one had to use a very high casting temperature, the use of plaster sleeves and exothermic sleeves would still be desirable.

MR. JACKSON agreed that that was so, and added that the use of the sleeves became progressively more important as the casting temperature was raised.

Further Information

MR. CHERRY asked if it would not be fair to say that Mr. Jackson was dealing with the 85/5/5/5 alloy, which had very little mobility, so to speak, within the pasty mass, and therefore the work which Gray had carried out with steel would hardly be likely to have its counterpart in 85/5/5/5. It would be interesting if the British Non-Ferrous Metals Research Association could look into that.

Next, he did not quite understand the statement in the third paragraph of the section of the Paper headed "Comments," that: "The present results show that with heavy-section sand castings, *e.g.*, the cylinder and block castings, the provision of feeder heads (insulated or otherwise) which freeze after the casting does not materially improve feeding of this kind, indeed there are indications that large or equivalent insulated feeders may increase the porosity in the casting, probably because they reduce its rate of solidification and flatten rather than steepen the temperature gradients from casting to feeder." If, he said, the Author had some figures resulting from the work on the test-casting shown in Fig. 2, they would be very interesting indeed.

Under the head "Conclusions" it was stated that: "Except in very large castings which may take hours to solidify and where exothermic sleeves would be unsuitable, these sleeves should be more effective than a plaster sleeve of similar size. . ." The speaker asked what were the Author's reasons for using the word "unsuitable."

MR. JACKSON, dealing with the point concerning the reduced mobility of 85/5/5/5 gunmetal in the pasty stage, said he was not able to answer because he had no information on this point. During that stage there was not any large-scale movement. The difference between (say) 4 per cent. and 3 per cent. porosity did not mean a particularly large movement of a mass of the metal; it was just that it was sufficiently mobile to move slightly and to transmit hydrostatic pressure.

With regard to the point about the large feeders possibly reducing the temperature gradients, he said the thermal curves obtained from castings where very large feeders were used showed that with feeder volumes of 30 or 40 cub. in. they did actually reduce the temperature gradient very substantially.

On the last point, concerning very large castings which froze slowly, he said the choice between an exothermic sleeve and a plaster sleeve rather depended on the thermal conductivity of the exothermic material after it had liberated all its heat, and it was probable that the conductivity in that latter stage was higher than that of the plaster sleeves. He thought the exothermic sleeve would probably be more useful where the freezing time was a matter of a few minutes, whereas if it were a matter of hours the reduced thermal conductivity of the plaster would be more effective than the initially higher metal temperature in the feeder, produced by the exothermic sleeve.

MR. CHERRY said he assumed Mr. Jackson would say that a sand-encased head 2 ft. dia. would freeze some time before an exothermic head of the same size. He presumed Mr. Jackson inferred that, if one put a large feeder on top of a small casting, one would materially delay the time of freezing of a small casting.

MR. JACKSON said that was so, due to the conductivity of the metal itself.

Practical Aspects

MR. G. J. ROGERS felt that papers of this type were very useful as showing what was happening, but he did not think they were of very much use to the practical foundryman. They were all right where large numbers of castings of the same type had to be made, but when dealing with foundry jobbing work one would not have time to work out according to a formula all that had to be done.

He had spent many years in the foundry and, as a generalization, would say that for the smaller gunmetal castings he would simply put on a good-size runner and a good-size gate to ensure sufficient pressure to feed the mould adequately; for the larger type of gunmetal casting he would advocate using the type of runner to give a semi-whirl-gate effect, to ensure that the hottest metal was retained in the runner, so that it thus became a

runner/feeder. On top of that he would use exothermic powder. For the larger castings, having a bulky boss or section, he would, and did, chill on every suitable occasion. From his experience he had no hesitation, whatsoever, in chilling at the bottom level, whether the sections were light or heavy, in order to stimulate the freezing in that particular area, which should freeze first. It was a very simple process, and if one kept the chills clean one would not run into any trouble. The method, of course, was simply the application of progressive directional solidification.

In his experience, exothermic sleeves were extremely fragile to handle and were costly. Rather than use them, he would prefer to use a riser 30 per cent. larger than one would use with the exothermic sleeve, and top it with an exothermic powder to prevent freezing at the top. One could depend on that much more than on cutting down the size of the riser to the minimum, and he had proved the economics to be better.

Coming to the CO_2 process, which was very simple indeed, Mr. Rogers said he was using it as a supplementary method for an insulating sleeve. His view was that if one had to make a casting which was heavy enough to warrant the use of a substantial feeder, the facing sand used to make the feeder should be CO_2 sand and the feeder topped with some exothermic material.

MR. JACKSON thanked Mr. Rogers for his practical comment. With regard to calculating the sizes of feeder sleeves, whether exothermic or insulating, to a large extent one must depend upon previous experience. In many cases, one had not the data on which to base the calculations, and often no time for calculations, anyway. Methods were then governed more by previous experience than by calculation.

It was interesting also to hear Mr. Roger's comments on enlarging the sprue to pressurize the smaller castings. That meant in fact using the runner also as a feeder, and one started off with the temperature gradients in the right direction; Mr. Jackson considered that this should be done wherever possible. It would moreover reduce fettling costs, since it would only be necessary to cut off at one point instead of at least two. As to chilling a casting at the bottom, he had no doubt whatever that, in the case of the 4- by 4- by 8-in. blocks, if he had put a copper or other metal chill at the bottom it would have reduced the porosity to well below the figure of 2½ per cent. which was given as the minimum in Fig. 4—it might well have gone to below 1 per cent.

He did not think he was the person to answer questions on the pros and cons of exothermic *versus* insulating sleeves, except to say that they would both do the work of keeping the metal in the feeder in the molten or semi-molten state for a sufficient time to pressurize the metal within the mould cavity. A technique which was quite often applied to the larger castings was to use an insulating feeder around the outside and to sprinkle exothermic powder on the top, and in that way one might get the best of both methods.

MR. ROGERS commented that one did indeed.

A SPEAKER, referring to Fig. 4, asked whether, if the feeder volume were considerably extended, one would obtain a second dip in the curve to where the temperature gradient was completely reversed, where the feeder was (say) twice the volume of the casting. In other words, had the Author made any very large header castings?

MR. JACKSON replied in the negative; the limit of that particular work was at a feeder volume of something like 45 cub. in. and he would not like to speculate on what happened beyond this point.

Conductivity of CO_2-bonded Sand

MR. J. L. RICE said he was not quite clear what Mr. Rogers had in mind when he had referred to the use of the CO_2 Process; was he using this Process to bind the exothermic material or was he saying that in a CO_2-sand mould the metal in the feeder head would stay liquid longer?

MR. ROGERS said he was referring to the use of a straightforward sand mould and putting a facing of CO_2-bonded sand about 1-in. thick around the header pattern. It was simple and one avoided all the labour of making an exothermic or plaster sleeve.

MR. RICE asked if that would not be more likely to chill the head, since there was evidence that, initially, a CO_2-type mould had a greater chilling power than a green-sand mould.

MR. ROGERS agreed this would be the case with small feeders but, with the thicker sections the chill seemed to be used up, as it were, and the sleeve became an insulator as heat was not dissipated through the mass. He had copied the method from Mr. Talbot of Western Foundries; for good feeding of sizeable castings, one should not use a feeding rod, but employ the CO_2 sand around the head. It did appear to have a temporary chilling effect, but eventually had an insulating effect which would remain for much longer than was normal with ordinary clay-bonded sands.

Effect of Vibration on Feeding

THE CHAIRMAN was interested in the fact that the discussion had veered round to the CO_2 Process, but he wondered if there were not some confusion of thought. He pointed out that a CO_2 mould was extremely permeable as compared with the normal mould for non-ferrous castings, and all knew that permeability had a marked influence on the soundness of the castings produced. He asked for Mr. Jackson's comments on the application of vibratory feeding, or the use of ultrasonic vibrations in conjunction with an exothermic feeder head.

MR. JACKSON said he had no figures concerning the permeability of the dry sand used in the work described in the Paper. It was a medium-grain silica sand with 5 per cent. of bentonite binder, and dried out. He would not care to hazard a guess as to its permeability and the effect it would have on the freezing. However, he believed that the rate at which the heat was taken out was dependent on the bulk specific heat and conductivity of the materials used.

Application of Insulated Feeders—Discussion

It was probable that the use of vibration in feeding would help in consolidating the mass, provided it was the type of vibration where the mass came down and then stopped suddenly each time, and not the sine-wave type of vibration. It could only be applied to ingots or castings where the shape of the top surface was either unimportant or was completely covered by a feeder, since the metal would tend to draw away from this surface. He pointed out, however, that by using vibration as a means of consolidation one could produce a banded structure; a layer of metal would be consolidated by each cycle. These layers might not join satisfactorily, and might well leave bands of porosity horizontally. Besides which, it was quite possible that it might bring about changes in the microstructure and interfere with inter-dendritic feeding such as was only too easy in horizontal-axis centrifugal castings.

"Breaker" Cones and Pre-ignition

MR. CHERRY said he had understood Mr. Jackson to suggest increasing the temperature in the head increased the temperature in the casting, flattening out the temperature-gradient.

MR. JACKSON interjected to point out that reference was made in connection with increasing the size, not the temperature.

MR. CHERRY then suggested that if the use of a very large head or of an insulated feeder had the effect of flattening out the temperature-gradient, the incorporation of a breaker core would look after that. He felt there was a tendency to regard exothermic material as something of which there was only one kind, whereas there were materials with varying characteristics. He pointed out that one sleeve recently made was in six parts; each part was hoisted into position in the head and was subjected to blows from a sledge hammer to ensure that it fitted. That was an example of a purely mechanical consideration and the material could be made as hard as was required.

Finally he referred to the statement at the end of the Paper that a possible drawback to the use of exothermic sleeves was the danger of gassing the metal, and he asked if the Author had considered the possibility of pre-igniting the sleeve. He himself had found it of advantage in casting high conductivity copper, which would seem to have a sort of "built-in" gas content.

MR. JACKSON felt that the discussion on exothermic materials and the production of exothermic sleeves of particular characteristics might well be left to those who made them, but those that he had used did in some cases tend to gas the metal, possibly by raising the temperature excessively in the head; he did not know if that were the explanation. In no cases in the work described in the Paper were the exothermic sleeves pre-ignited. The investigators had relied on the hot metal coming into contact with the exothermic material to ignite it.

A breaker core, he said, might well have an effect on the temperature gradient, but there was another point to be considered. In the case of the long-freezing-range alloys, especially when poured at the lower temperatures, the metal did not feed in the same way as (say) mild steel or aluminium-bronze, where there was a very deep "V" in the feeder head; with this range of alloys the whole feeder sank down more or less bodily into the casting, and a breaker core at the bottom would prevent such movement. He felt that this would nullify any beneficial effect it might have on the temperature gradient.

THE CHAIRMAN, in thanking Mr. Jackson for his Paper and for the able way in which he had replied to questions, said that interest had been keen throughout the meeting and the discussion very enlightening.

Increases in Capital

BOOTHAM ENGINEERS, LIMITED, increased by £20,000, in £1 ordinary shares, beyond the registered capital of £30,000.

HALLIDAY BOILERS, LIMITED, London, S.E.25, increased by £10,000, in £1 ordinary shares, beyond the registered capital of £5,000.

GEORGE BROWN & SONS, ENGINEERS (LEITH), LIMITED, increased by £40,000, in £1 shares, beyond the registered capital of £20,000.

CLYDE TUBE FORGINGS, LIMITED, Glasgow, increased by £40,000, in £1 ordinary shares, beyond the registered capital of £20,000.

SURREY IRON COMPANY, LIMITED, Farnham (Surrey), increased by £10,000, in £1 ordinary shares, beyond the registered capital of £25,000.

WILLIAM DOXFORD & SONS (ENGINEERS), LIMITED, Sunderland, increased by £1,249,900, in £1 ordinary shares, beyond the registered capital of £100.

T. S. HARRISON & SONS, LIMITED, engineers, etc., of Heckmondwike, increased by £125,000, in £1 ordinary shares, beyond the registered capital of £25,000.

NORTH BRITISH STEEL FOUNDRY, LIMITED, Bathgate (West Lothian), increased by £100,000, in £1 shares, beyond the registered capital of £200,000.

ANDERSON-GRICE COMPANY, LIMITED, Carnoustie (Angus), increased by £44,500, in 356,000 2s. 6d. ordinary shares, beyond the registered capital of £5,000.

COVENTRY MACHINE TOOL WORKS, LIMITED, Boothtown, Halifax (Yorks), increased by £150,000, in 4s. ordinary shares, beyond the registered capital of £150,000.

Changes of Name

Among the companies which have recently changed their names are those listed below. The new titles are given in parentheses.

COALPORT ENTERPRISES, LIMITED, High Street, Madeley, Salop (Steel Fabrications (Madeley), Limited).

MONMOUTH WELDING (CONSTRUCTION) COMPANY, LIMITED, The Forge, Osbaston, Mon (Monmouth Construction, Limited).

H. A. J. LAWRENCE & SONS, LIMITED, engineers, etc., Trinity Street, Leamington Spa (Lawrence (Everett) & Company, Limited).

BRIGHTSIDE ENGINEERING HOLDINGS, LIMITED, Ecclesfield, near Sheffield (Brightside Foundry & Engineering Company, Limited).

DUDLEY BOWER, LIMITED, electrical and general engineers, etc., of Briset House, 6/9, Briset Street, London, E.C.1 (Dudley Bower & Company, Limited).

The A.E.I. Lamp & Lighting Company, Limited, announces the appointment of Mr. B. J. ROBINSON to the post of regional publicity assistant for the Midland region. He will be responsible for the showroom which was opened at the company's Midland region headquarters at 26-28, Holloway Head, Birmingham, 1, on September 3.

Hall "P"

Brilliant Castings Exhibition at Düsseldorf

Foundrymen participating in the International Foundry Congress at Düsseldorf, September 1 to 9—and there were about 3,000 of them—were unanimously of the opinion that the accompanying exhibitions were without parallel in the history of the industry. That statement was subscribed to also by the American contingent, despite the fact that large biennial "foundry" exhibitions are attractions at their own congresses. The British participants were, quite frankly, "kicking themselves" because the opportunity that presented itself at last year's international congress in London of holding co-related exhibitions was missed. The main reason for the admiration of the visitors was centred in Hall "P" of the exhibitions where to the exclusion of plant and supplies, a magnificent display of castings themselves was the main attraction. Here, there were shown the products of iron, steel and non-ferrous foundries from the largest to the smallest, from simple cylinders to castings with amazingly tortuous coring. Also in this hall were the stands of the European Committee for Foundries and of other foreign nations (not including Great Britain) and a large special exhibit of the *Verein Deutscher Giessereifachleute,* the German Foundrymen's Association, on "Design and Casting" in addition to a display arranged by the *Zentrale fur Gussverwendung* (Information Centre on Castings Application).

Sizeable Castings

The impact of massiveness is always an effective curtain-raiser for an exhibition and in this respect, Hall "P" was well introduced even by the castings outside (see last week's issue of the JOURNAL for illustrations). Flanking the entrance, on the right-hand side, was a cast-steel roll-housing weighing about 250 tons (made by Bochumer Verein), while on the left side was a carillon of thirty or more bells gleaming when the sun shone and playing tunes at intervals. Beyond these were two intricate steel castings, one of 32 tons, a second of rather more, a 60-ton flywheel and a 22-ton ship's frame.

Inside the hall, one was early impressed by the group display of castings and services offered by the *Syndicat Generale des Fondeurs de France;* later came finished machines, their component castings painted distinctively—a motor-car, a tractor and so on. Everywhere was a spaciousness, attention to fine detail and enlightened display probably never before associated with the foundry industry, Even the most phlegmatic layman could not fail to be favourably impressed with the technical and artistic merit of founding. "Exhibition finish" was everywhere apparent, of course, but since there were few exceptions, the layman was given every excuse for believing this was quite the normal. Really outstanding, even among this excellence, was the German Association's own exhibit, mentioned previously. This was housed within the hall in its own "glass-case", a covered Perspex building some 50 yards long and 25 yards wide with entrance and exit so arranged that visitors saw all that was offered. Somehow, the mere fact of seeing others inside the "glass-case" seemed to make a person wish to examine what they were looking at and impel him to enter—a psychological effect which British exhibition organizers will no doubt bear in mind. Literally, thousands of castings, founding methods, drawings, graphs, diagrams, photographs all were tastefully arranged here.

Other Stands

Other sections of Hall "P" included a stand devoted to shell-moulding equipment (though why this was so housed among the exhibits mainly of finished castings is a little difficult to understand). This well-documented display presented the products of the German firm associated with the British Polygram concern. It invariably attracted a crowd, though the only machine really new seemed to be a four-station rotary shell producer, with pressure conveying of the sand/resin mix to the patternplate. Also impressive were the stands of the Mond Nickel Company and their associates; a display of non-ferrous castings by Demag (this latter including some copper tuyere-boxes and blast-furnace cooler castings), and the group stand of the Association of Precision-investment Founders (here, among the 27 firms represented were the names of five British concerns—Deloro Stellite, Deritend Precision Castings, Joseph Lucas, Trucast and P.I. Altrincham). Notable castings on various stands included a large variable-pitch propeller and a Francis-turbine wheel of about 17-ft. dia. and 40 tons finished weight, cast in 13 per cent. chrome steel by Bochumer Verein AG; a Pelton wheel 10-ft. dia. by the same firm and in the same material; a paper-machine hollow roll casting 20-ft. dia. by about the same width; a number of intricately finned air-cooled cylinders made in built-up shell moulds; a 30-ton steel work-table (on the Huttenwerk Salzgitter stand); yet another cast-steel propeller (by Klockner Gorgsmarienwerke AG) weighing 12 tons, and a grand-piano frame.

Minor criticisms could be levelled no doubt—for instance, there were insufficient inscriptions and too few leaflets printed in three languages—but taken on the whole, the display was brilliant and well worthy of emulation on other suitable occasions elsewhere. Solely as a prestige exhibit, its value for the world's foundry industry (and the German industry in particular) must be enormous. Those who try to follow or improve, however, set themselves a tremendous task, for the "thunder," namely the value of being first and at once excellent has been so very well realized at Düsseldorf.

News in Brief

THE telephone number of the Hydronyl Syndicate, Limited, chemical engineers, of 14, Gloucester Road, London, S.W.7, is now KNIGHTSBRIDGE 6803.

THE WALLSEND SHIPYARD of Swan, Hunter, & Wigham Richardson, Limited, has been reconstructed to enable ships of 65,000 tons deadweight to be built.

THE ADDRESS of the registered office of the Battelle Institute, Limited, will, as from last Monday, be 24, Ryder Street, St. James's, London, S.W.1 (telephone: TRAFALGAR 1621).

RICHARD SUTCLIFFE, LIMITED, mining machinery manufacturers, etc., of Horbury, Wakefield, announces that its export and London area office is now at 28-29, Savile Row, W.1 (telephone: REGENT 5764).

HONEYWELL-BROWN, LIMITED, manufacturers of industrial instruments and automatic controls, of Greenford, Middlesex, has appointed Mr. D. Tallon as its resident representative in Eire. His address is 38, Upper Mount Street, Dublin.

PROVISIONAL ESTIMATES by the Board of Trade show that the index number for the total value of stocks and work in progress in manufacturing industry (end 1954=100) rose to 120 at the end of June, compared with 117 at the end of March.

INDUSTRY will spend 1 per cent. more on plant, machinery and vehicles and 9 per cent. less on building work in 1957 than in 1956, according to estimates by the Board of Trade based on returns by companies replying to a sample inquiry.

A BAGHDAD REPORT states that the English Electric Company, Limited, has been given the contract for mechanical and electrical equipment for the Dokan dam in North Iraq. The Iraqi Development Board stated that the contract was awarded because the tender of £321,391 sterling was a "suitable offer."

ON SEPTEMBER 8, George Kent, Limited, engineers, etc., held its seventh "open day" at its Luton factories. Most production departments and offices at the Biscot Road works and the recently completed Lea works were open to families and friends of employees. It is estimated that 3,500 people visited the two factories.

AT A COST of $1,250,000 the American Smelting & Refining Company is to expand its Perth Amboy, New Jersey, facilities for continuously casting bronze foundry alloys. The expansion will begin this year and will increase the plant's capacity by about 50 per cent. Two new continuous casting furnaces will be installed.

A MEMBERS' MEETING of the Association of Bronze and Brass Founders is to be held on September 25 at the Clarendon Restaurant, Hammersmith, at 11.45. This will be followed by an advisory service meeting (open to all bronze and brass founders in the area) at 2.15 p.m., at which Mr. L. H. Tarring will speak about the operation of the metal market.

THE TECHNICAL COLLEGE, Coventry, is organizing, commencing on September 28, a series of 12 lectures on foundry techniques. The course costs only a guinea, and the lecturers are all well-established experts in the subject they cover. The course can be unreservedly recommended to those located in the Coventry area. Details are available from the principal of the College.

A CONTRACT valued at £689,000 for an outdoor switching station has been received from the Central Electricity Authority by the General Electric Company, Limited. All equipment for the station—to be erected near Wolverhampton—with the exception of the 275 kv circuit-breakers to be built by A. Reyrolle & Company, Limited, under a sub-contract, will be made by the GEC at Witton.

FIGURES issued by the Ministry of Labour and National Service show that the number of people in civil employment in Great Britain in July was 23,040,000, having risen by 10,000 during the month. The manufacturing industries showed a fall of more than 20,000, mainly in vehicles and engineering, the overall increase being due to greater employment in seasonal trades and services.

THE University of Sheffield and the United Steel Companies, Limited, have come to an agreement for the purchase and installation of a Ferranti Pegasus digital computer. The £50,000 computer, which has already been ordered from Ferranti, Limited, is to be delivered in March, 1958, and will ultimately be installed in a new mathematics block at the University, for which approval has just been given. Sheffield University and United Steel will each use the machine for their own research programmes.

THE BRITISH STANDARDS *Information Sheet* for August under "*Amendment Slips Issued*" includes No. 592:1950 Carbon steel castings for general engineering purposes (amendment No. 2), PD 2,512; No. 1,121 Part 33: 1955 Methods for the determination of iron in ores, slags and refractories (amendment No. 2, superseding amendment No. 1), PD 2,530; No. 1,456: 1948 1½ per cent. manganese steel castings (amendment No. 2), PD 2,508; and No. 1,457:1948 Austenitic manganese steel castings (amendment No. 2), PD 2,509.

THE BIRMINGHAM BRANCH of the Institute of British Foundrymen is holding a meeting on September 26, at the James Watt Memorial Institute, Great Charles Street, when Mr. T. H. Weaver will present his presidential address and Mr. J. Hill will speak on the "Mechanized Coreshop for Blowing of Small- and Medium-sized Cores." The South African branch of the Institute will hold a meeting on September 27, at 8 p.m., at Barclays Bank Building, Johannesburg, when the subject of a talk by Dr. L. B. Knoll will be "What the Engineer Requires from the Foundrymen."

WHEN FOUNDRY SERVICES, LIMITED, of Birmingham, open their new factory at Drayton Manor, Near Tamworth, they will depart from the conventional method of inviting a well-known personality to perform the opening ceremony. Instead the company is inviting 1,000 of its foundry customers to an "open week" beginning on Monday, September 24. It is claimed that the new factory will be the largest and most up-to-date of its kind in the world for the manufacture of chemical and metallurgical products, for the treatment of molten metals and of the moulds into which they are cast.

WHEN THE NO. 2 BLAST FURNACE at the Redbourn steel works of Richard Thomas and Baldwins, Limited, is relined this month, all workers in the area will be asked to wear protective footwear and helmets. This is an item in the intensive safety campaign which is being organized by the works' new executive safety committee. Already charger drivers in the melting shop are wearing combined helmets and visors, and types of helmets, goggles and gloves are being tested in all workshops. Safety stewards are being appointed to maintain a link between shopfloor workers, and the safety committees are to be responsible for display boards.

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Personal

Stanton Ironworks Company, Limited, announce that Mr. R. E. STEVENSON, who has been area sales representative in the South Midlands for a number of years, has been appointed to the position of Cardiff manager to replace Mr. R. G. SAUNDERS, who has retired.

Mr. ROBERT C. RODGER, managing director of Cockburns, Limited, valve manufacturers, etc., of Glasgow, and a director of the Atlas Steel Foundry & Engineering Company, Limited, has been elected to the board of the Associated Bakeries & General Investment Company, Limited.

Mr. R. MCKINNON WOOD, chairman of Griffin & George, Limited, Wembley, Middlesex, has been appointed vice-chairman of the committee, under the chairmanship of Professor Willis Jackson, which will advise the Government on the recruiting and training of technical college teachers.

AT THE ANNUAL MEETING of the Cutlers' Company on September 10, Mr. FREDERICK PICKWORTH, managing director of the English Steel Corporation, Limited, was nominated as senior warden, and Mr. JAMES HUGH NEILL, a director of James Neill & Company (Sheffield), Limited, was nominated junior warden.

Mr. KENNETH WOOD, a lecturer in metallurgy at Sheffield College of Technology, has been appointed lecturer in metallurgy at Oxford College of Technology. He holds the degree in metallurgy of Sheffield University, and has previously taught at Barnsley and Workington Technical Colleges.

Mr. W. E. DAVIS, Midland Regional Controller of the Ministry of Labour, received a cheque from his colleagues at a ceremony in Birmingham, on September 10, to mark his retirement. The presentation was made by Mr. J. W. ELDRIDGE, the deputy controller. He is being succeeded in the post of regional controller which he has held since 1952, by Mr. Eldridge.

Mr. S. C. TYRRELL, local director and assistant managing director of the excavators division of Newton Chambers & Company, Limited, and Mr. K. E. WALKER, local director and assistant managing director of the engineering division, have been appointed directors of the company. Mr. S. L. WAIDE, local director and general manager of the company's chemical division, has been appointed an assistant managing director.

The Council of the British Institute of Management announces the election of Mr. JOHN RYAN, C.B.E., M.C., and Mr. H. V. STAMMERS, D.F.C., as its vice-chairmen. They will assist Mr. H. WILMOT, C.B.E., chairman and managing director of Beyer, Peacock & Company, Limited, who was recently elected as chairman of the Council. Mr. John Ryan is vice-chairman of the Metal Box Company, Limited, and a part-time member of the British Transport Commission. Mr. H. V. Stammers is deputy chairman of the British Tabulating Company, Limited.

Mr. R. C. THOMPSON, chairman of Joseph L. Thompson & Sons, Limited, shipbuilders, of Sunderland, will be installed as president of the North-East Coast Institution of Engineers and Shipbuilders at Newcastle-upon-Tyne on October 12. Mr. Thompson is a Fellow of the Institution and was elected chairman in April. He is also a former chairman of the Wear Shipbuilders' Association. Some days after his installation Mr. Thompson will be the guest of honour at the annual dinner of the North of England Shipowners' Association.

Mr. W. J. MCBRIAN, vice-president of the Caterpillar Tractor Company, who is to become chairman of the company's British subsidiary, the Caterpillar Tractor Company, Limited, Desford (Leics), as from November 1, will continue to hold office as a vice-president of the US company. Mr. W. J. BORNHOLDT, managing director of the subsidiary since its organization in 1950, will return to the US at the end of this year, when Mr. McBrian will also become managing director of the subsidiary, and its operating headquarters will be transferred from Desford to Glasgow.

Mr. G. W. ASHTON, superintendent of Shepcote Lane Rolling Mills, Limited, Sheffield, has been appointed a special director of the company. Mr. Ashton went to Samuel Fox & Company, Limited, in 1943 as technical assistant to the production engineer and general works manager. He was mainly responsible for the installation of fine wire mills, rolling mills, and clock spring production. In 1947 he was appointed to the joint technical and advisory committee set up by Firth-Vickers Stainless Steels, Limited, and Samuel Fox & Company, which was responsible for the decision to build and operate the Shepcote Lane Rolling Mills; Mr. Ashton was made superintendent when it was opened.

Obituary

Mr. GEORGE MILLS, founder of George Mills (Engineers), Limited, Beckenham (Kent), has died at the age of 77.

Mr. ALFRED SLATER, Ministry of Labour industrial relations officer for Scotland, who died on September 11 at the age of 59, had a long record of service with the Ministry in Glasgow, Aberdeen, and Orkney. He had been mainly concerned with industrial relations for the past 14 years. Mr. Slater succeeded Mr. J. Foulds as industrial relations officer for Scotland only three months ago.

The death is announced of Mr. A. KREMENER who after a successful career as foundry manager in Berlin, pioneered the castings industry of Israel. He started up the well-known Vulcan foundry at Haifa, using raw refugee labour from mainly Eastern Europe. The foundry became well established and in recent years Mr. Kremener, acted as consultant. At one time he was in charge of one of the ministries of his country. In his semi-retirement he founded and became the first president of the Foundries Association of Israel. He was well known in this country, the Middle East and on the Continent of Europe.

Mr. THOMAS CLARK, C.A., assistant director of the Joint Iron Council, died on September 14. He was in his fifty-fourth year. Mr. Clark was born in Wishaw, and educated at Hutcheson's Boys' Grammar School, Glasgow. He trained as an accountant and after qualifying in 1934, he joined Moores, Carson & Watson, chartered accountants, Glasgow. He was in charge of the work and organization connected with trade associations in the iron, steel and timber trades, including the British Wrought Iron Association, the Scottish Association for Rolled and Re-rolled Steel Products and the Pitwood Association. In 1943 he took up the appointment of secretary of the National Gas Organisations in Scotland. In 1945 he was appointed secretary of the Joint Iron Council, the Council of Iron Producers, the Foundry Pig Iron Producers' Association and the Cast Iron Pipe Association. In January, this year, Mr. Clark was appointed assistant director of the Joint Iron Council.

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Raw Material Markets

Iron and Steel

Production of high-duty castings in the engineering and speciality foundries is at a good level. Outputs, however, are not up to those attained some months ago, as the motor-car industry is specifying less freely and many of the foundries which mainly cater for that trade are still on short-time working. Their pig-iron consumption has, in consequence, been reduced and this has released increased tonnages for the busier foundries, which are now able to obtain their full requirements. Makers of hematite are able to dispose of their outputs readily, as, apart from the quantities sent to the foundries, the steelworks utilize a large proportion of available supplies.

Pressure for low-phosphorus iron is reduced and producers are able to cope with demands, but no appreciable stocks are being carried either by the furnaces or the foundries.

Most of the light-castings foundries are seeking new business. Improved trade is reported from some areas, but demands generally are subdued and only moderate business is being done by many of the jobbing and textile foundries. This is reflected in the call for high-phosphorus pig-iron; production is reduced, but makers are able to deal comfortably with demands.

Foundries are getting fairly good quantities of scrap, while coke is coming forward in sufficient quantities to provide some stock. Ganister, limestone, and firebricks are obtained without difficulty.

The re-rollers remain very busy. Order-books are full for all their products of small bars, light sections, etc., and they have sufficient orders on hand to justify maximum outputs for some months ahead. Home consumers are specifying freely, while there is more business on offer from overseas than can be accepted at present. Most of the re-rollers have good supplies of steel semis. Home supplies have been augmented by consignments from abroad and stocks at the mills have been increased. There is, however, no reduction in the demands on home steelworks, particularly for the smaller sizes, and also for special quality steel billets.

Non-ferrous Metals

Tin, for a change, is occupying most of the limelight in the non-ferrous metal markets. Last week the price rose by £44 5s. to reach its highest price in London for six months and its peak level in Singapore for six years. The course of events at the Suez was responsible for the steep climb in the quotation, which, on analysis, proved to have a high content of scare buying. This was particularly true in the East, where Japanese and Indian buying vied with American demand to bring about a shortage of Straits metal. All this was basically due to fears of an interruption of supplies sent via the Suez. On Saturday, however, the Eastern price fell heavily and London reacted in sympathy on Monday.

Copper, both in London and in New York, has been kept firm by the Suez situation and by the widespread unrest on the Rhodesian Copperbelt. Not so long ago major influences of this kind would have sent the price soaring. That it has not done so can be taken as a strong indication that supplies on both sides of the Atlantic are adequate to meet current demand. Should the troubles in the East and in Rhodesia clear up, a lower price can be looked for, provided always, of course, that a sudden sustained upsurge in demand does not emerge in the US.

There is a more hopeful attitude about the Rhodesian strike situation following the appeal of the president of the Northern Rhodesia African Mineworkers' Union to the African miners to return to work.

Demand for lead is again quietly steady in London and good in New York. Zinc remains an active market on both sides of the Atlantic.

Official metal prices were as follow:—

COPPER, Standard—*Cash:* September 13, £309 to £309 10s.; September 14, £313 to £313 10s.; September 17, £309 10s. to £310 10s.; September 18, £304 to £304 10s.; September 19, £295 to £296.

Three Months: September 13, £308 10s. to £309; September 14, £311 to £312; September 17, £308 to £309; September 18, £302 10s. to £303 10s.; September 19, £294 to £294 10s.

TIN, Standard—*Cash:* September 13, £807 to £808; September 14, £827 to £828; September 17, £810 to £812 10s.; September 18, £801 to £802; September 19, £789 to £791.

Three Months: September 13, £799 to £800; September 14, £815 to £817 10s.; September 17, £802 10s. to £805; September 18, £791 to £792; September 19, £779 to £781.

LEAD—*First half September:* September 13, £118 15s. to £119; September 14, £118 to £118 10s. *Second half September:* September 17, £118 to £118 5s.; September 18, £117 to £117 5s.; September 19, £116 5s. to £116 15s.

First half December: September 13, £116 5s. to £116 10s.; September 14, £116 to £116 5s. *Second half December:* September 17, £116 to £116 5s.; September 18, £115 to £115 10s.; September 19, £114 10s. to £114 15s.

ZINC—*First half September:* September 13, £97 to £97 5s.; September 14, £96 15s. to £97 5s. *Second half September:* September 17, £96 to £96 10s.; September 18, £96 to £96 5s.; September 19, £95 10s. to £96.

First half December: September 13, £94 15s. to £95; September 14, £94 10s. to £95. *Second half December:* September 17, £94 to £94 5s.; September 18, £94 to £94 5s.; September 19, £93 15s. to £94.

BECAUSE of the difficulty in housing their metallurgist, it is claimed that Reynolds Light Alloys cannot commence operations at their new foundry at Redditch.

AT THE MEETING of the West Riding of Yorkshire branch of the Institute of British Foundrymen, to be held on September 22, at the Technical College, Bradford, Mr. L. L. Allard will deliver his presidential address at 6.30 p.m. (preceded by tea at 4.45 p.m.). The address will be followed by two films—"The Invisible Shield," and "Modern Malleable."

THE PROGRAMME of lectures which has been prepared by the Tees-side branch of the Institute of British Foundrymen for this session is probably unique in that the authors of all the lecturers have been drawn from the branch membership. The branch Council is certainly to be congratulated on securing the co-operation of so many of its own members.

THE BIRMINGHAM AND DISTRICT INDUSTRIAL SAFETY GROUP has submitted a fixture list of 28 lecture courses which have been organized between now and next Easter. Amongst the subjects covered are works maintenance; crane driving and slinging; electrical maintenance and industrial truck driving. Details are available from Mr. Appleyard, 21, Steelhouse Lane, Birmingham, 4.

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Current Prices of Iron, Steel, and Non-ferrous Metals

(Delivered unless otherwise stated)

September 19, 1956

PIG-IRON

Foundry Iron.—No. 3 IRON, CLASS 2:—Middlesbrough, £17 11s. 0d.; Birmingham, £17 3s. 3d.

Low-phosphorus Iron.—Over 0.10 to 0.75 per cent. P, £20 8s. 0d., delivered Birmingham. Staffordshire blast-furnace low-phosphorus foundry iron (0.10 to 0.50 per cent. P, up to 3 per cent. Si), d/d within 60 miles of Stafford, £20 12s. 3d.

Scotch Iron.—No. 3 foundry, £21 14s. 6d., d/d Grangemouth.

Cylinder and Refined Irons.—North Zone, £23 16s. 6d.; South Zone, £23 19s. 0d.

Refined Malleable.—P, 0.10 per cent. max.—North Zone, £25 4s. 0d.; South Zone, £25 6s. 6d.

Hematite.—Si up to 2 per cent., S. & P. over 0.03 to 0.05 per cent. :—N.-E. of England (local iron), £21 7s. 6d.; Scotland (Scotch iron), Zone S. 1, £21 14s. 0d.; Sheffield, £22 14s. 6d.; Birmingham, £23 2s. 0d.; Wales (Welsh iron), £21 7s. 6d.

Basic Pig-iron.—£18 3s. 0d. all districts.

FERRO-ALLOYS

(Per ton unless otherwise stated, delivered)

Ferro-silicon (6-ton lots and over).—45 per cent. Si, £48 0s. 0d. to £50 5s. 0d., scale 16s. 0d. to 17s. 6d. per unit; 75 per cent. Si, £70 0s. 0d. to £73 2s. 6d., scale 16s. 0d. to 17s. 6d. per unit.

Ferro-vanadium.—50/60 per cent., 27s. 6d. per lb. of V.

Ferro-molybdenum.—65/75 per cent., carbon-free, 11s. 6d. per lb. of Mo.

Ferro-titanium.—20/25 per cent., carbon-free, £250 0s. 0d.; 38/40 per cent., £299 0s. 0d.

Ferro-tungsten.—80/85 per cent., 16s. 10d. per lb. of W.

Tungsten Metal Powder.—98/99 per cent., 19s. 10d. per lb. of W.

Ferro-chrome (6-10 ton lots).—4/6 per cent.C, £93 10s.0d. to £95 0s. 0d., basis 60 per cent. Cr, scale 29s. 9d. to 32s. 0d. per unit; over 6 per cent. C, £92 10s. 0d. to £93 0s. 0d., basis 60 per cent. Cr, scale 29s. 9d. to 32s. 0d. per unit; 2 per cent. C,* 2s. 1d. per lb. Cr; 1 per cent. C,* 2s. 1½d. per lb. Cr; 0.15 per cent. C,* 2s. 2½d. per lb. Cr; 0.10 per cent. C,* 2s. 2¾d. per lb. Cr; 0.06 per cent. C,* 2s. 3d. per lb. Cr.

Metallic Chromium.—98/99 per cent., 7s. 0d. to 7s. 6d. per lb.

Metallic Manganese.—93/95 per cent., carbon-free, £249 0s. 0d.; 96/98 per cent., £259 0s. 0d. to £265 0s. 0d.

Ferro-columbium.—65/75 per cent., Nb + Ta, 22s. 6d. to 23s. 6d. per lb., Nb + Ta.

Ferro-manganese (home).—78 per cent., £66 0s. 0d.

SEMI-FINISHED STEEL

Re-rolling Billets, Blooms, and Slabs.—BASIC: Soft, u.t., £28 19s. 0d.; tested, 0.08 to 0.25 per cent. C, £29 19s. 0d.; hard (0.41 to 0.60 per cent. C), £31 0s. 6d.; silico-manganese, £39 10s. 0d.; free-cutting, £33 3s. 0d. SIEMENS MARTIN ACID: Up to 0.25 per cent. C, £36 14s. 6d., silico-manganese, £39 17s. 6d.

Billets, Blooms, and Slabs for Forging and Stamping.—Basic, soft, up to 0.25 per cent. C, £34 13s. 6d.; basic, hard, over 0.41 up to 0.60 per cent., C, £35 16s. 0d.; acid, up to 0.25 per cent. C, £38 17s. 6d.

FINISHED STEEL

Heavy Plates and Sections.—Ship plates (N.-E. Coast), £35 7s. 0d.; boiler plates (N.-E. Coast), £37 17s. 0d.; floor plates (N.-E. Coast), £36 16s. 0d.; sectional material, N.-E. Coast, £33 16s. 6d.

Small Bars, Sheets, etc.—Rounds and squares, under 3 in., untested (4-ton lots), £36 3s. 0d.; flats, 5 in. wide and under (4-ton lots), £36 3s. 0d.; hoop and strip, £36 12s. 6d.; uncoated strip mill coils, hot rolled, under 3mm. to 12g., £38 16s. 0d.; black sheets (hand mill), 17/20 g., £50 4s. 6d.; galvanized corrugated sheets, 24 g., £62 2s. 0d.

Alloy Steel Bars.—1 in. dia. and up: Nickel, £61 13s. 9d.; nickel-chrome, £85 10s. 6d.; nickel-chrome-molybdenum, £96 16s. 6d.

NON-FERROUS METALS

Copper.—Cash, £295 0s. 0d. to £296 0s. 0d.; three months, £294 0s. 0d. to £294 10s. 0d.; settlement, £296 0s. 0d.

Copper Tubes, etc.—Solid-drawn tubes, 2s. 11½d. per lb.; rods, 347s. 6d. per cwt. basis: 20 s.w.g., 380s. 9d. per cwt.

Tin.—Cash, £789 0s. 0d. to £791 0s. 0d.; three months, £779 0s. 0d. to £781 0s. 0d.; settlement, £791 0s. 0d.

Lead (Refined Pig).—Second half September, £116 5s. 0d. to £116 15s. 0d.; second half December, £114 10s. 0d. to £114 15s. 0d.

Zinc.—Second half September, £95 10s. 0d. to £96 0s. 0d.; second half December, £93 15s. 0d. to £94 0s. 0d.

Zinc Sheets, etc.—Sheets, 15 g. and thicker, all English destinations, £127 15s. 0d.; rolled zinc (boiler plates), all English destinations, £125 10s. 0d.; zinc oxide (Red Seal), d/d buyers' premises, £110.

Brass Tubes, etc.—Solid-drawn tubes, 2s. 5½d. per lb.; rods, drawn, 3s. 3¾d.; sheets to 10 w.g., 315s. 9d. per cwt.; wire, 3s. 1½d.; rolled metal, 310s. 9d. per cwt.

Brass (Brazing).—BS1400, B3 (65/35), £205; B6 (85/15), —; BS249, —.

Brass (High Tensile).—BS1400, HTB1 (30 tons), £253; HTB2 (38 tons), —; HTB3 (48 tons), —.

Gunmetal.—BS RCH, £272; BS1400, LG2 (85/5/5/5), £279; LG3 (86/7/5/2), £287; G1 (88/10/2/½), £348; (88/10/2/1), £335.

Phosphor Bronze.—BS1400, PB1 (AID released), £354 per ton.

Phosphor Bronze Strip, etc.—Strip, 451s. 3d. per cwt.; sheets to 10 w.g., 475s. 9d. per cwt.; wire, 4s. 7½d. per lb.; rods, 3s. 11½d.; tubes, 3s. 9¾d.; chill cast bars: solids 3s. 10½d., cored 3s. 11½d. (CHARLES CLIFFORD, LIMITED).

Nickel Silver, etc.—Rolled metal, 3 in. to 9 in. wide × 0.056, 4s. 2d. per lb.; round wire, 10g. in coils (10 per cent.), 4s. 6¾d.; special quality turning rod, 10 per cent., ½ in. dia., in straight lengths, 4s. 5½d. All prices are net.

Other Metals.—Magnesium, ingots, 2s. 4d. per lb. Antimony, English, 99 per cent., £210 0s. 0d. Quicksilver, ex-warehouse, £83 10s. 0d. Nickel, £519 0s. 0d. Aluminium ingots, £198 10s. 0d.; aluminium bronze (BS1400), AB1, £313; AB2, £326. Solder, brazing, BS1945, type 8 (50/50), 3s. 1½d. per lb., type 9 (54/46), 3s. 5d. per lb.

* Average 68–70 per cent.